Jacaranda Geoactive 1

NSW AUSTRALIAN CURRICULUM GEOGRAPHY STAGE 4 FOURTH EDITION

Jacaranda Geoactive 1

NSW AUSTRALIAN CURRICULUM GEOGRAPHY STAGE 4 FOURTH EDITION

Louise SWANSON

Nicole GRAY

Karen BOWDEN

Adrian HARRISON

Kymberly GOVERS

Steven NEWMAN

CONTRIBUTING AUTHORS

Judy MRAZ

Jill PRICE

Cathy BEDSON

Jeana KRIEWALDT

Denise MILES

jacaranda

A Wiley Brand

Fourth edition published 2017 by
John Wiley & Sons Australia, Ltd
42 McDougall Street, Milton, Qld 4064

First edition published 1998
Second edition published 2005
Third edition published 2010

Typeset in 11/12 pt Adobe Garamond Pro

© Susan Bliss, John Paine 1998, 2005, 2010

© John Wiley & Sons Australia, Ltd 2017

The moral rights of the authors have been asserted.

National Library of Australia
Cataloguing-in-publication data

Title:	Geoactive 1 Stage 4 NSW for the Australian curriculum / Louise Swanson, Nicole Gray, Karen Bowden, Adrian Harrison, Kymberly Govers, Steven Newman.
ISBN:	978 0 7303 3032 5 (paperback) 978 0 7303 3035 6 (ebook)
Notes:	Includes index.
Target Audience:	For secondary school age.
Subjects:	Physical geography — Australia — Textbooks. Geography — Australia — Textbooks. Australia — Geography — Textbooks.
Other Creators/ Contributors:	Gray, Nicole, author. Bowden, Karen, author. Harrison, Adrian, author. Govers, Kymberly, author. Newman, Steven, author.
Dewey Number:	910.712

Reproduction and communication for educational purposes
The Australian *Copyright Act 1968* (the Act) allows a maximum of one chapter or 10% of the pages of this work, whichever is the greater, to be reproduced and/or communicated by any educational institution for its educational purposes provided that the educational institution (or the body that administers it) has given a remuneration notice to Copyright Agency Limited (CAL).

Reproduction and communication for other purposes
Except as permitted under the Act (for example, a fair dealing for the purposes of study, research, criticism or review), no part of this book may be reproduced, stored in a retrieval system, communicated or transmitted in any form or by any means without prior written permission. All inquiries should be made to the publisher.

Trademarks
Jacaranda, the JacPLUS logo, the learnON, assessON and studyON logos, Wiley and the Wiley logo, and any related trade dress are trademarks or registered trademarks of John Wiley & Sons Inc. and/or its affiliates in the United States, Australia and in other countries, and may not be used without written permission. All other trademarks are the property of their respective owners.

Cover images: Rainer Albiez / Shutterstock; Nasupnick / Shutterstock.com

Internal design images: GarryKillian / Shutterstock;
gasa / Shutterstock.com; VoodooDot / Shutterstock.com;
HTU/Shutterstock.com; Design Seed / Shutterstock.com

Cartography by Spatial Vision, Melbourne and MAPgraphics Pty Ltd, Brisbane

Illustrated by various artists, diacriTech and Wiley Composition Services

Typeset in India by diacriTech

Printed in Singapore by
Markono Print Media Pte Ltd

10 9 8 7 6 5 4 3

This textbook contains images of Indigenous people who are, or may be, deceased. The publisher appreciates that this inclusion may distress some Indigenous communities. These images have been included so that the young multicultural audience for this book can better appreciate specific aspects of Indigenous history and experience.

It is recommended that teachers should first preview resources on Indigenous topics in relation to their suitability for the class level or situation. It is also suggested that Indigenous parents or community members be invited to help assess the resources to be shown to Indigenous children. At all times the guidelines laid down by the relevant educational authorities should be followed.

CONTENTS

How to use this resource x
About eBookPLUS xiv
Acknowledgements xv

CHAPTER 1 The world of Geography 2

1.1 Overview 2
1.2 Geographical concepts 9
1.3 Work and careers in Geography 15
1.4 **Review** 18

TOPIC 1 LANDSCAPES AND LANDFORMS



CHAPTER 2 The diversity and formation of landscapes and landforms 22

2.1 Overview 22
2.2 What are different types of landscapes? 24
2.3 What types of landscapes and landforms are there in Australia? 26
2.4 **SkillBuilder:** Recognising land features eBookplus ONLINE ONLY 32
2.5 What types of landscapes are found in the Pacific region? eBookplus ONLINE ONLY 32
2.6 What processes transform landscapes? 32
2.7 Which landscapes are created by water? 35
2.8 How are landscapes created underground? 37
2.9 How are river landscapes created? eBookplus ONLINE ONLY 39
2.10 How are coastal landscapes shaped by erosion? eBookplus ONLINE ONLY 39
2.11 How are coastal landscapes shaped by deposition? eBookplus ONLINE ONLY 39
2.12 How do I undertake coastal fieldwork? 40
2.13 **SkillBuilder:** Constructing a field sketch eBookplus ONLINE ONLY 43
2.14 **SkillBuilder:** How to read a map eBookplus ONLINE ONLY 43
2.15 **Investigating topographic maps:** What are topographic maps? 44
2.16 **Review** eBookplus ONLINE ONLY 45
Key terms eBookplus ONLINE ONLY

CHAPTER 3 Valuing, managing and protecting landscapes and landforms 46

3.1 Overview 46
3.2 Why do people value landscapes and landforms? 48
3.3 How do landscapes and landforms have cultural and spiritual value? 50
3.4 What are the economic values of landscapes and landforms? 52
3.5 **SkillBuilder:** Using positional language eBookplus ONLINE ONLY 54
3.6 How are landscapes protected and managed? 55
3.7 Kakadu — Australia's first World Heritage Area eBookplus ONLINE ONLY 58
3.8 Why is Uluru an iconic Australian landform? 58
3.9 How is Uluru protected and managed? 61
3.10 How have humans changed and degraded landscapes? 62
3.11 What are geomorphic hazards? 64
3.12 **SkillBuilder:** Using topographic maps eBookplus ONLINE ONLY 69
3.13 **Investigating topographic maps:** What is the value of Gunnedah Shire? 70
3.14 **Review** eBookplus ONLINE ONLY 71
Key terms eBookplus ONLINE ONLY

CHAPTER 4 Desert landscapes 72

4.1 Overview 72
4.2 What is a desert? 74
4.3 What type of climate forms deserts? 76
4.4 What are the processes that shape desert landforms? 81
4.5 What are the characteristics of Australia's deserts? 85
4.6 How did Lake Mungo become dry? 87
4.7 How do people use deserts? 90
4.8 **SkillBuilder:** Using latitude and longitude eBookplus ONLINE ONLY 93
4.9 **SkillBuilder:** Calculating distance using scale eBookplus ONLINE ONLY 93
4.10 **Investigating topographic maps:** How do people manage deserts? 94
4.11 Is Antarctica a desert? eBookplus ONLINE ONLY 94
4.12 How do people use Antarctica? eBookplus ONLINE ONLY 94
4.13 **Review** eBookplus ONLINE ONLY 95
Key terms eBookplus ONLINE ONLY

CHAPTER 5 Mountain landscapes 96

5.1 Overview 96
5.2 Where are the world's mountains? 98
5.3 How do people use mountains? 100
5.4 What are the forces that form mountains? 104

5.5 How do different types of mountains form? 106
5.6 How do earthquakes and tsunamis occur? 110
5.7 What are the impacts of earthquakes and tsunamis? 114
5.8 **SkillBuilder:** Drawing a simple cross-section eBookplus ONLINE ONLY 117
5.9 **SkillBuilder:** Interpreting an aerial photo eBookplus ONLINE ONLY 117
5.10 How are volcanic mountains formed? eBookplus ONLINE ONLY 117
5.11 **Investigating topographic maps:** How did Mount Taranaki form? 118
5.12 What is the anatomy of a volcano? 120
5.13 How do volcanoes affect people? 122
5.14 **Review** eBookplus ONLINE ONLY 125
Key terms eBookplus ONLINE ONLY

CHAPTER 6 Rainforest landscapes 126

6.1 Overview 126
6.2 What are the characteristics of a rainforest? 128
6.3 **SkillBuilder:** Understanding thematic maps eBookplus ONLINE ONLY 130
6.4 What is a rainforest ecosystem like? 131
6.5 **SkillBuilder:** Creating and describing complex overlay maps eBookplus ONLINE ONLY 133
6.6 How have Australia's rainforests changed? 134
6.7 How is the Amazon rainforest changing? eBookplus ONLINE ONLY 136
6.8 **SkillBuilder:** Drawing a précis map eBookplus ONLINE ONLY 136
6.9 How do indigenous people use rainforests? 136
6.10 Why are rainforests disappearing? 139
6.11 How does deforestation affect the environment and people? 141
6.12 How can rainforests be conserved? 145
6.13 **Investigating topographic maps:** What are features of the Daintree rainforest? 148
6.14 **Review** eBookplus ONLINE ONLY 149
Key terms eBookplus ONLINE ONLY

CHAPTER 7 Fieldwork inquiry: How does a waterway change from source to sea? 150

7.1 Overview 150
7.2 Inquiry process 150
7.3 **Review** **151**

TOPIC 2 PLACE AND LIVEABILITY



CHAPTER 8 Where do Australians live? 154

8.1 Overview 154
8.2 What creates a sense of place? 156
8.3 Why do people live in certain places? 159
8.4 Where do you live and why? 163
8.5 **SkillBuilder:** Interpreting population profiles eBookplus ONLINE ONLY 165
8.6 Why do Australians live in remote places? 166
8.7 What draws people to rural areas? 169
8.8 **Investigating topographic maps:** What draws people to Griffith? 172
8.9 Are rural communities sustainable? eBookplus ONLINE ONLY 172
8.10 What are 'lifestyle' places? 174
8.11 Where is my place? 176
8.12 **SkillBuilder:** Constructing a basic sketch map eBookplus ONLINE ONLY 179
8.13 Where would you like to live? 180
8.14 **Review** eBookplus ONLINE ONLY 183
Key terms eBookplus ONLINE ONLY

CHAPTER 9 People and places 184

9.1 Overview 184
9.2 Where do most Australians live? 186
9.3 **SkillBuilder:** Understanding satellite images eBookplus ONLINE ONLY 188
9.4 **SkillBuilder:** Using alphanumeric grid references eBookplus ONLINE ONLY 189
9.5 Services and facilities important to wellbeing 189
9.6 How does distance affect lifestyle? 191
9.7 What is life like in a rural town? 193
9.8 Environmental quality and liveability eBookplus ONLINE ONLY 195
9.9 **Investigating topographic maps:** What makes Mount Etna a dangerous place to live? 196
9.10 What influences community identity? 198
9.11 What are remote settlements like? 201
9.12 What is Old Delhi like? eBookplus ONLINE ONLY 203
9.13 How is modern India changing? eBookplus ONLINE ONLY 203
9.14 **Review** eBookplus ONLINE ONLY 203
Key terms eBookplus ONLINE ONLY

CHAPTER 10 Liveable places 204

10.1 Overview 204
10.2 What is liveability? 206
10.3 What makes a place liveable? 208
10.4 **SkillBuilder:** Drawing a climate graph eBookplus ONLINE ONLY 210
10.5 Where are the most liveable cities? 211
10.6 What makes Melbourne the world's most liveable city? eBookplus ONLINE ONLY 213
10.7 How can liveability be improved? 213
10.8 **Investigating topographic maps:** What is liveability like in Badu and Moa? 216
10.9 Port Moresby — a less liveable city? 218

10.10 Dhaka — a less liveable city? eBook plus ONLINE ONLY 220
10.11 What makes a place liveable for you? 220
10.12 **SkillBuilder:** Creating and analysing overlay maps eBook plus ONLINE ONLY 222
10.13 How could my community be made more liveable? 222
10.14 **Review** eBook plus ONLINE ONLY 225
Key terms eBook plus ONLINE ONLY

CHAPTER 11 Geographical inquiry: What is my place like? 226

11.1 Overview 226
11.2 Inquiry process 226
11.3 **Review** 227

TOPIC 3 WATER IN THE WORLD



CHAPTER 12 Water in the world 230

12.1 Overview 230
12.2 What is a resource? 232
12.3 Is water a renewable resource? 234
12.4 **SkillBuilder:** Interpreting diagrams eBook plus ONLINE ONLY 236
12.5 How much water is there in the world? eBook plus ONLINE ONLY 236
12.6 How is groundwater used as a resource? 236
12.7 How does water flow through catchments? 239
12.8 What factors affect water availability? 241
12.9 What is the difference between weather and climate? 244
12.10 **SkillBuilder:** Reading a synoptic chart eBook plus ONLINE ONLY 247
12.11 **Investigating topographic maps:** How does water flow down the Haast River? 248
12.12 Why does the wind blow? eBook plus ONLINE ONLY 250
12.13 How strong is the wind? eBook plus ONLINE ONLY 250
12.14 **Review** eBook plus ONLINE ONLY 250
Key terms eBook plus ONLINE ONLY

CHAPTER 13 Water resources and the water cycle 252

13.1 Overview 252
13.2 How is water used by people? 254
13.3 **SkillBuilder:** Drawing a line graph eBook plus ONLINE ONLY 256
13.4 What is the value of water? 257
13.5 **SkillBuilder:** Annotating a photograph eBook plus ONLINE ONLY 259
13.6 What is the economic value of water? 259
13.7 How does access to water improve health? 261
13.8 What is the cultural and spiritual value of water? 263
13.9 How do Indigenous people use water? 265
13.10 How is water significant to indigenous people? 267
13.11 What is the aesthetic and social value of water? 269
13.12 What is virtual water? 271
13.13 **Investigating topographic maps:** How is water valued in Noosa? 274
13.14 **Review** eBook plus ONLINE ONLY 275
Key terms eBook plus ONLINE ONLY

CHAPTER 14 Water scarcity and management 276

14.1 Overview 276
14.2 Where are Australia's water resources? 278
14.3 How does Australia's climate affect water availability? 279
14.4 What differences are there in water availability globally? 282
14.5 Does everyone have enough water? 284
14.6 **SkillBuilder:** Constructing a pie graph eBook plus ONLINE ONLY 287
14.7 What is water scarcity? 287
14.8 **SkillBuilder:** Reading and describing basic choropleth maps eBook plus ONLINE ONLY 291
14.9 What strategies can address water scarcity? 292
14.10 How can water be managed? 294
14.11 **Investigating topographic maps:** What are sources of water at Whataroa? 298
14.12 **Review** eBook plus ONLINE ONLY 298
Key terms eBook plus ONLINE ONLY

CHAPTER 15 Too much wind, too much water 300

15.1 Overview 300
15.2 How is a natural hazard different from a natural disaster? 302
15.3 **SkillBuilder:** Cardinal points: wind rose eBook plus ONLINE ONLY 305
15.4 Why does it flood? 305
15.5 What are the impacts of floods? 307
15.6 **SkillBuilder:** Creating a simple column or bar graph eBook plus ONLINE ONLY 310
15.7 How do places around the world manage floods? 310
15.8 How do tornadoes impact people and environments? 312
15.9 What was the impact of the May 2013 tornado in the United States? eBook plus ONLINE ONLY 315
15.10 What is a cyclone? 315
15.11 What impact did Cyclone Yasi have? eBook plus ONLINE ONLY 317

15.12 What are the impacts of typhoons in Asia? 318
15.13 How do we respond to extreme weather and water events? 320
15.14 How do we manage extreme weather and water events? 322
15.15 **Investigating topographic maps:** How does flooding affect the Narrabeen lagoon? 326
15.16 **Review** eBookplus ONLINE ONLY 327
Key terms eBookplus ONLINE ONLY

CHAPTER 16 Fieldwork inquiry: What is the water quality of my local catchment? 328
16.1 Overview 328
16.2 Inquiry process 328
16.3 **Review** 329

TOPIC 4 INTERCONNECTIONS



CHAPTER 17 Personal connections 332
17.1 Overview 332
17.2 Why do we travel? 334
17.3 Travel patterns 338
17.4 **SkillBuilder:** Constructing and describing a doughnut chart eBookplus ONLINE ONLY 340
17.5 Sport, recreation and leisure 341
17.6 Cultural tourism 343
17.7 Impacts of travel 345
17.8 **SkillBuilder:** Creating a survey eBookplus ONLINE ONLY 347
17.9 **SkillBuilder:** Describing divergence graphs eBookplus ONLINE ONLY 347
17.10 Future trends and sustainability 348
17.11 Sustainability and ecotourism 350
17.12 **Investigating topographic maps:** How does nature drive tourism at Victoria Falls? 352
17.13 **Review** eBookplus ONLINE ONLY 352
Key terms eBookplus ONLINE ONLY

CHAPTER 18 Technology connecting people 354
18.1 Overview 354
18.2 Transport and technology 356
18.3 **Investigating topographic maps:** How do we use Port Botany? 358
18.4 Transport connecting people with places 360
18.5 Differences in connections of people with places 362
18.6 **SkillBuilder:** Interpreting topological maps eBookplus ONLINE ONLY 364
18.7 How do we communicate? 364
18.8 ICT and increased connection to services and information 367
18.9 ICT and increased connection to people 369
18.10 Impacts of global connectivity on people and places 371
18.11 **SkillBuilder:** Constructing and describing isoline maps eBookplus ONLINE ONLY 373
18.12 **Review** eBookplus ONLINE ONLY 373
Key terms eBookplus ONLINE ONLY

CHAPTER 19 Buy, swap, sell and give 374
19.1 Overview 374
19.2 How does trade connect us? 376
19.3 **SkillBuilder:** Constructing and describing a flow map eBookplus ONLINE ONLY 380
19.4 How does trade connect Australia with the world? 381
19.5 How is food traded around the world? 385
19.6 **SkillBuilder:** Constructing multiple line and cumulative line graphs eBookplus ONLINE ONLY 388
19.7 How are markets and factories linked? 388
19.8 **Investigating topographic maps:** How is Singapore linked to other places? 394
19.9 How has international automotive trade changed? 396
19.10 Are global players altering the industrial landscape? 398
19.11 Why is fair trade important? 401
19.12 Why does Australia give foreign aid? 403
19.13 Why is the illegal wildlife trade a cause for concern? eBookplus ONLINE ONLY 405
19.14 **Review** eBookplus ONLINE ONLY 405
Key terms eBookplus ONLINE ONLY

CHAPTER 20 For better or worse? 406
20.1 Overview 406
20.2 Who has access to technology? 408
20.3 **SkillBuilder:** Constructing a table of data for a GIS eBookplus ONLINE ONLY 410
20.4 What are the consequences of unequal access? 410
20.5 How has technology improved lives in developing countries? 413
20.6 How has technology improved in Australia? 415
20.7 How are e-wastes managed? 418

20.8 How does e-cycling work? eBook plus ONLINE ONLY 422
20.9 How can you reduce your consumption? 423
20.10 **Investigating topographic maps:** Can waste be managed more sustainably? 426
20.11 **SkillBuilder:** Using advanced survey techniques — interviews eBook plus ONLINE ONLY 428
20.12 **Review** eBook plus ONLINE ONLY 428
Key terms eBook plus ONLINE ONLY

CHAPTER 21 Fieldwork inquiry: What are the effects of travel in the local community? 430
21.1 Overview 430
21.2 Inquiry process 430
21.3 **Review** 431

Glossary *433*
Index *439*

HOW TO USE THIS RESOURCE

Jacaranda Geoactive 1 NSW Australian Curriculum Geography Stage 4, 4th Edition, consists of your textbook as well as a wealth of online resources. The structure and features of the textbook and eBookPLUS are described here.

'Geographical concepts' is a valuable reference section that covers each of the seven concepts.

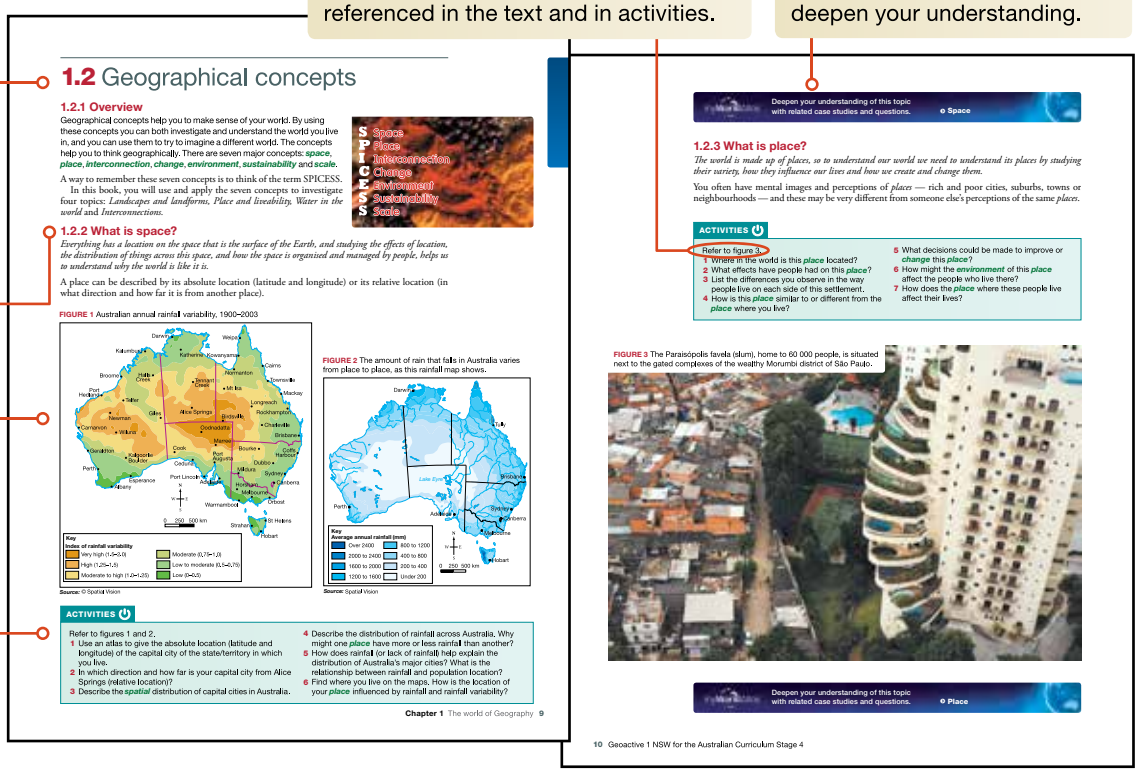
Each concept is clearly defined.

A variety of visual resources support the explanations.

A series of activities to build and develop your understanding of each concept is provided.

Easily identifiable visual material is referenced in the text and in activities.

myWorld Atlas links extend and deepen your understanding.



1.2 Geographical concepts

1.2.1 Overview

Geographical concepts help you to make sense of your world. By using these concepts you can both investigate and understand the world you live in, and you can use them to try to imagine a different world. The concepts help you to think geographically. There are seven major concepts: ***space, place, interconnection, change, environment, sustainability*** and ***scale***.

A way to remember these seven concepts is to think of the term SPICESS.

In this book, you will use and apply the seven concepts to investigate four topics: *Landscapes and landforms, Place and liveability, Water in the world* and *Interconnections*.

S Space
P Place
I Interconnection
C Change
E Environment
S Sustainability
S Scale

1.2.2 What is space?

Everything has a location on the space that is the surface of the Earth, and studying the effects of location, the distribution of things across this space, and how the space is organised and managed by people, helps us to understand why the world is like it is.

A place can be described by its absolute location (latitude and longitude) or its relative location (in what direction and how far it is from another place).

FIGURE 1 Australian annual rainfall variability, 1900–2003

FIGURE 2 The amount of rain that falls in Australia varies from place to place, as this rainfall map shows.

ACTIVITIES

Refer to figures 1 and 2.
1 Use an atlas to give the absolute location (latitude and longitude) of the capital city of the state/territory in which you live.
2 In which direction and how far is your capital city from Alice Springs (relative location)?
3 Describe the *spatial* distribution of capital cities in Australia.
4 Describe the distribution of rainfall across Australia. Why might one *place* have more or less rainfall than another?
5 How does rainfall (or lack of rainfall) help explain the distribution of Australia's major cities? What is the relationship between rainfall and population location?
6 Find where you live on the maps. How is the location of your *place* influenced by rainfall and rainfall variability?

Chapter 1 The world of Geography 9

Deepen your understanding of this topic with related case studies and questions. ⊕ Space

1.2.3 What is place?

The world is made up of places, so to understand our world we need to understand its places by studying their variety, how they influence our lives and how we create and change them.

You often have mental images and perceptions of *places* — rich and poor cities, suburbs, towns or neighbourhoods — and these may be very different from someone else's perceptions of the same *places*.

ACTIVITIES

Refer to figure 3.
1 Where in the world is this *place* located?
2 What effects have people had on this *place*?
3 List the differences you observe in the way people live on each side of this settlement.
4 How is this *place* similar to or different from the *place* where you live?
5 What decisions could be made to improve or *change* this *place*?
6 How might the *environment* of this *place* affect the people who live there?
7 How does the *place* where these people live affect their lives?

FIGURE 3 The Paraisópolis favela (slum), home to 60 000 people, is situated next to the gated complexes of the wealthy Morumbi district of São Paulo.

Deepen your understanding of this topic with related case studies and questions. ⊕ Place

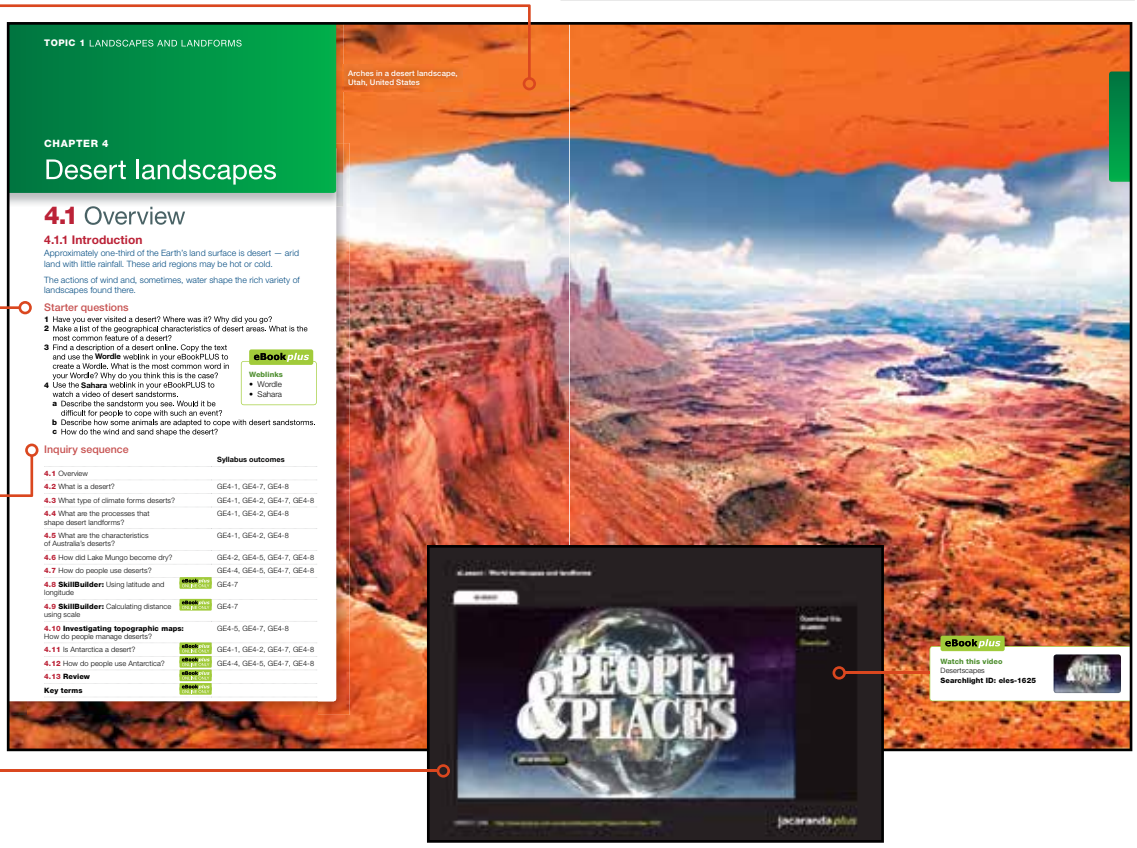
10 Geoactive 1 NSW for the Australian Curriculum Stage 4

Evocative and informative images stimulate interest and discussion.

Starter questions raise issues, link the chapter to your life, and prompt you to think about what you already know and feel about the topic being investigated.

A sequence for your inquiry is provided.

A specially commissioned *People and places* video clip provides an overview of each chapter.



TOPIC 1 LANDSCAPES AND LANDFORMS

Arches in a desert landscape, Utah, United States

CHAPTER 4

Desert landscapes

4.1 Overview

4.1.1 Introduction

Approximately one-third of the Earth's land surface is desert — arid land with little rainfall. These arid regions may be hot or cold.

The actions of wind and, sometimes, water shape the rich variety of landscapes found there.

Starter questions

1 Have you ever visited a desert? Where was it? Why did you go?
2 Make a list of the geographical characteristics of desert areas. What is the most common feature of a desert?
3 Find a description of a desert online. Copy the text and use the **Wordle** weblink in your eBookPLUS to create a Wordle. What is the most common word in your Wordle? Why do you think this is the case?
4 Use the **Sahara** weblink in your eBookPLUS to watch a video of desert sandstorms.
a Describe the sandstorm you see. Would it be difficult for people to cope with such an event?
b Describe how some animals are adapted to cope with desert sandstorms.
c How do the wind and sand shape the desert?

eBookplus Weblinks
• Wordle
• Sahara

Inquiry sequence

	Syllabus outcomes
4.1 Overview	
4.2 What is a desert?	GE4-1, GE4-7, GE4-8
4.3 What type of climate forms deserts?	GE4-1, GE4-2, GE4-7, GE4-8
4.4 What are the processes that shape desert landforms?	GE4-1, GE4-2, GE4-8
4.5 What are the characteristics of Australia's deserts?	GE4-1, GE4-2, GE4-8
4.6 How did Lake Mungo become dry?	GE4-2, GE4-5, GE4-7, GE4-8
4.7 How do people use deserts?	GE4-4, GE4-5, GE4-7, GE4-8
4.8 **SkillBuilder:** Using latitude and longitude	GE4-7
4.9 **SkillBuilder:** Calculating distance using scale	GE4-7
4.10 **Investigating topographic maps:** How do people manage deserts?	GE4-5, GE4-7, GE4-8
4.11 Is Antarctica a desert?	GE4-1, GE4-2, GE4-7, GE4-8
4.12 How do people use Antarctica?	GE4-4, GE4-5, GE4-7, GE4-8
4.13 Review	
Key terms	

PEOPLE & PLACES

eBookplus
Watch this video
Deserscapes
Searchlight ID: eles-1625

Each section begins with a clearly identifiable spread number and inquiry question.

Integrated digital resources reinforce and expand understanding.

Key terms are explained.

Engaging and informative visuals promote understanding.

Scaffolding is provided to assist you to write extended written pieces and develop literacy skills.

Graded activities address the NSW syllabus for the Australian curriculum.

References to online material to go to next are provided.

This section includes a range of different activities useful for reviewing the chapter, especially prior to a test.

Italicised key concepts are applied to the content in the spread.

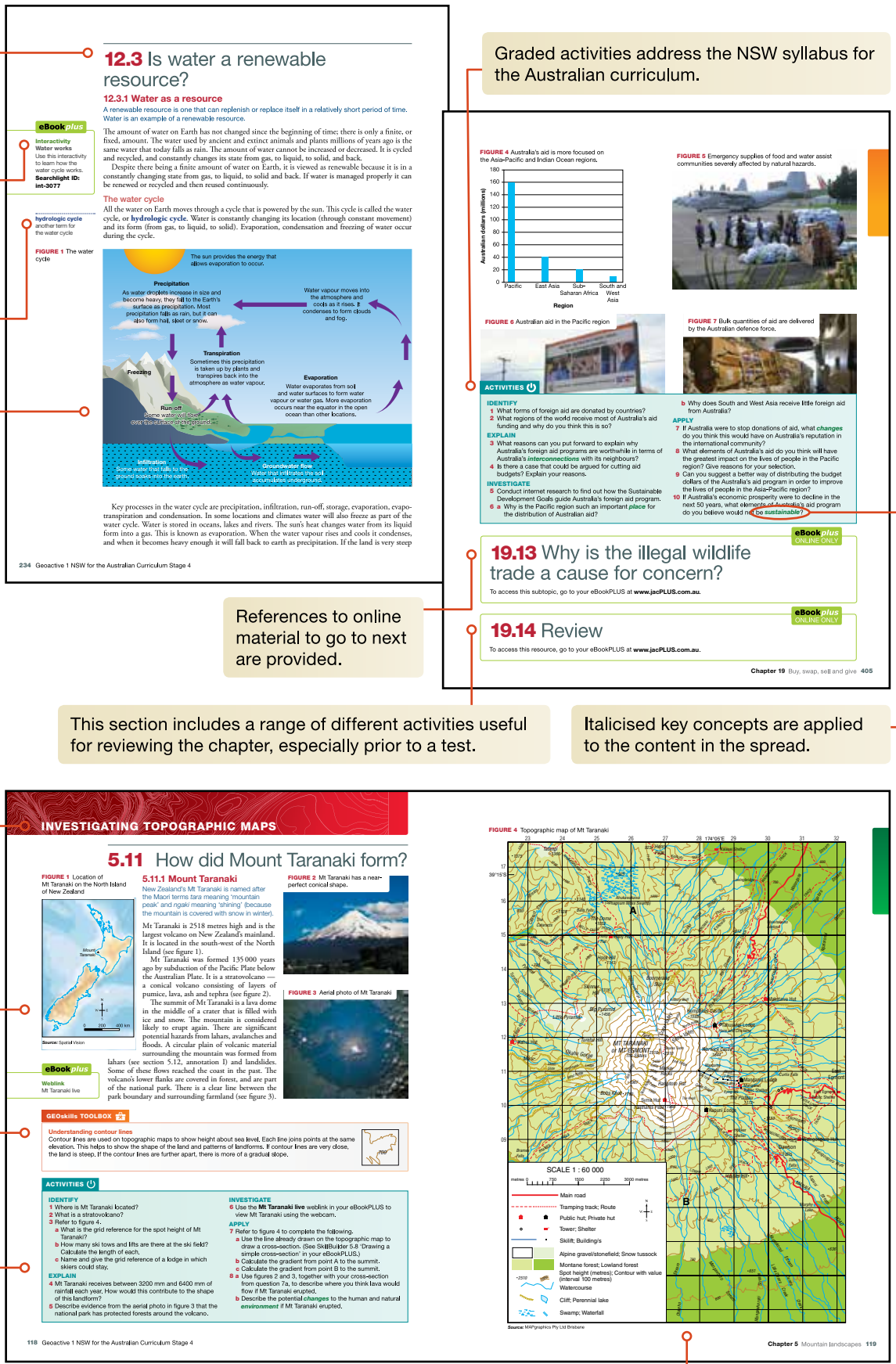
Develop your map interpretation skills in the context of the topic you are investigating.

Introductory text, maps and images provide background information.

Succinct summaries of geographical tools are provided.

Graded activities guide analysis of each topographic map extract.

Clear and custom-designed topographic maps enable development of map interpretation skills.



Integrated digital resources reinforce and expand understanding.

Two SkillBuilder links for each chapter develop and model key geographical skills in context.

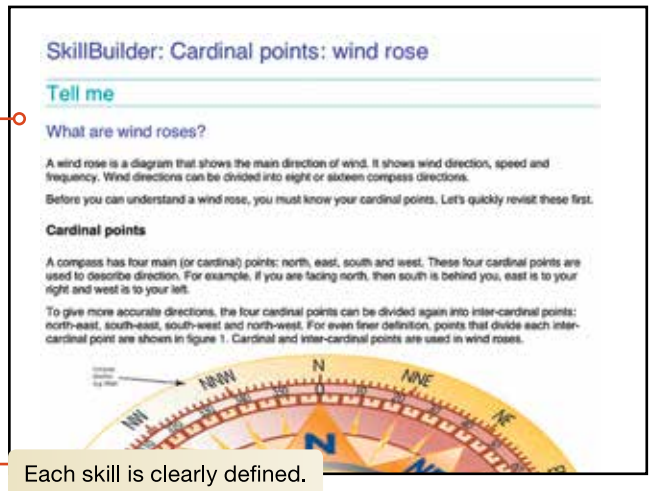
Ideas, information and tips help you collect, process and communicate fieldwork data.

The Fieldwork Inquiry and Geographical Inquiry ProjectsPLUS provide you with an opportunity to develop your inquiry skills in the field and through research.

You are guided through creative online projects using ProjectsPLUS. These are designed to engage students and provide quality assessment support for teachers, with an innovative management system featuring multimedia and project templates.

New worksheets have been designed to consolidate learning for students with learning support needs (including Life Skills students). Each worksheet is mapped to a life skill outcome.

About SkillBuilders


SkillBuilder: Cardinal points: wind rose

Tell me

What are wind roses?

A wind rose is a diagram that shows the main direction of wind. It shows wind direction, speed and frequency. Wind directions can be divided into eight or sixteen compass directions.

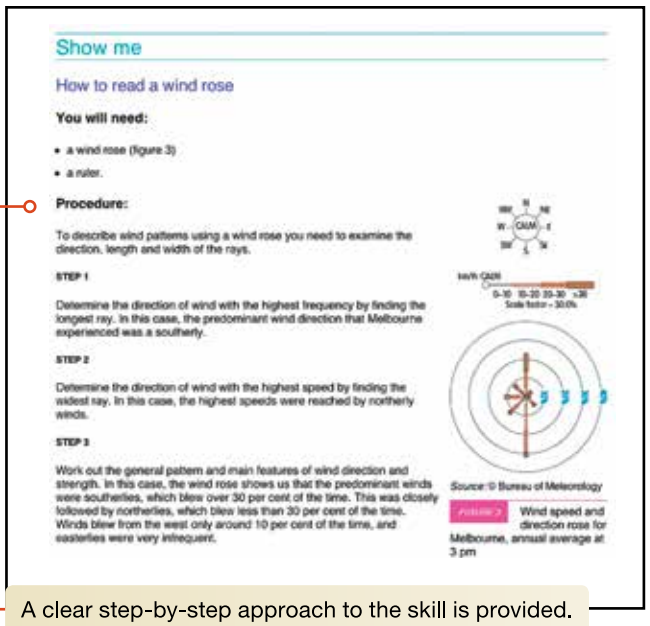
Before you can understand a wind rose, you must know your cardinal points. Let's quickly revisit these first.

Cardinal points

A compass has four main (or cardinal) points: north, east, south and west. These four cardinal points are used to describe direction. For example, if you are facing north, then south is behind you, east is to your right and west is to your left.

To give more accurate directions, the four cardinal points can be divided again into inter-cardinal points: north-east, south-east, south-west and north-west. For even finer definition, points that divide each inter-cardinal point are shown in figure 1. Cardinal and inter-cardinal points are used in wind roses.

Each skill is clearly defined.


Show me

How to read a wind rose

You will need:

- a wind rose (figure 3)
- a ruler.

Procedure:

To describe wind patterns using a wind rose you need to examine the direction, length and width of the rays.

STEP 1

Determine the direction of wind with the highest frequency by finding the longest ray. In this case, the predominant wind direction that Melbourne experienced was a southerly.

STEP 2

Determine the direction of wind with the highest speed by finding the widest ray. In this case, the highest speeds were reached by northerly winds.

STEP 3

Work out the general pattern and main features of wind direction and strength. In this case, the wind rose shows us that the predominant winds were southerlies, which blew over 30 per cent of the time. This was closely followed by northerlies, which blew less than 30 per cent of the time. Winds blew from the west only around 10 per cent of the time, and easterlies were very infrequent.

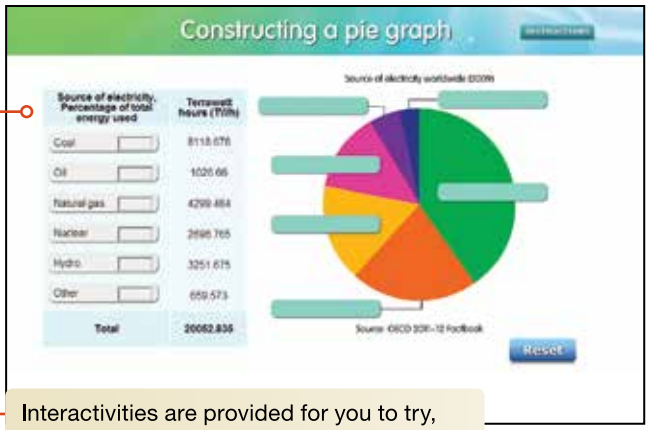
Source: © Bureau of Meteorology

FIGURE 2 Wind speed and direction rose for Melbourne, annual average at 3 pm

A clear step-by-step approach to the skill is provided.



eLessons visually explain, and model, the steps in the process for each skill.


Constructing a pie graph

Source of electricity. Percentage of total energy used

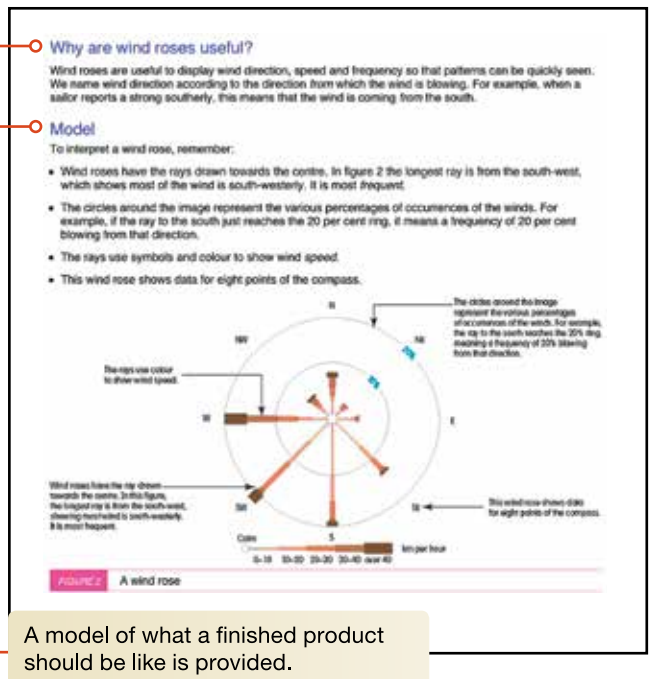
Terawatt hours (TWh)

Coal
Oil
Natural gas
Nuclear
Hydro
Other
Total

Reset

Interactivities are provided for you to try, focusing on key aspects of each skill.

The importance of the skill for you as a Geography student is explained.


Why are wind roses useful?

Wind roses are useful to display wind direction, speed and frequency so that patterns can be quickly seen. We name wind direction according to the direction from which the wind is blowing. For example, when a sailor reports a strong southerly, this means that the wind is coming from the south.

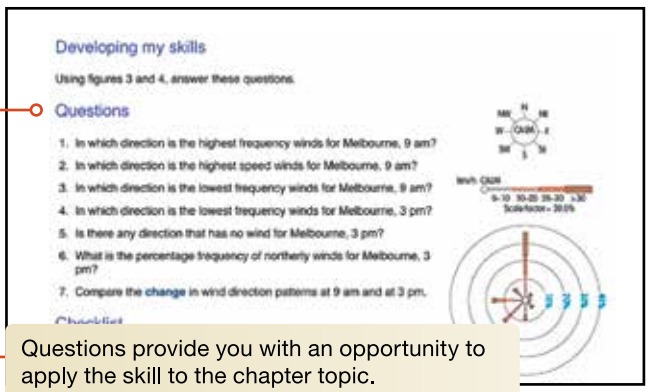
Model

To interpret a wind rose, remember:

- Wind roses have the rays drawn towards the centre. In figure 2 the longest ray is from the south-west, which shows most of the wind is south-westerly. It is most frequent.
- The circles around the image represent the various percentages of occurrences of the winds. For example, if the ray to the south just reaches the 20 per cent ring, it means a frequency of 20 per cent blowing from that direction.
- The rays use symbols and colour to show wind speed.
- This wind rose shows data for eight points of the compass.

FIGURE 2 A wind rose

A model of what a finished product should be like is provided.


Developing my skills

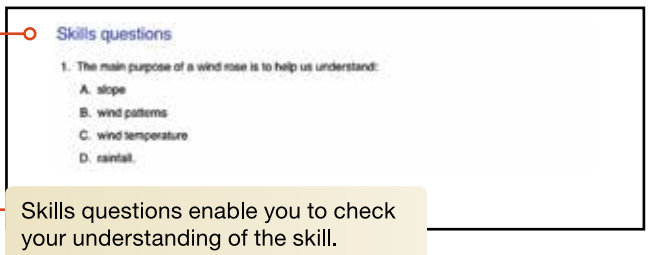
Using figures 3 and 4, answer these questions.

Questions

1. In which direction is the highest frequency winds for Melbourne, 9 am?
2. In which direction is the highest speed winds for Melbourne, 9 am?
3. In which direction is the lowest frequency winds for Melbourne, 9 am?
4. In which direction is the lowest frequency winds for Melbourne, 3 pm?
5. Is there any direction that has no wind for Melbourne, 3 pm?
6. What is the percentage frequency of northerly winds for Melbourne, 3 pm?
7. Compare the change in wind direction patterns at 9 am and at 3 pm.

Checklist

Questions provide you with an opportunity to apply the skill to the chapter topic.


Skills questions

1. The main purpose of a wind rose is to help us understand:
   A. slope
   B. wind patterns
   C. wind temperature
   D. rainfall.

Skills questions enable you to check your understanding of the skill.

About eBookPLUS

jacaranda *plus*

This book features eBookPLUS: an electronic version of the entire textbook and supporting digital resources. It is available for you online at the JacarandaPLUS website (**www.jacplus.com.au**).



Using JacarandaPLUS

To access your eBookPLUS resources, simply log on to **www.jacplus.com.au** using your existing JacarandaPLUS login and enter the registration code. If you are new to JacarandaPLUS, follow the three easy steps below.

Step 1. Create a user account
The first time you use the JacarandaPLUS system, you will need to create a user account. Go to the JacarandaPLUS home page (**www.jacplus.com.au**), click on the button to create a new account and follow the instructions on screen. You can then use your nominated email address and password to log in to the JacarandaPLUS system.

Step 2. Enter your registration code
Once you have logged in, enter your unique registration code for this book, which is printed on the inside front cover of your textbook. The title of your textbook will appear in your bookshelf. Click on the link to open your eBookPLUS.

Step 3. Access your eBookPLUS resources
Your eBookPLUS and supporting resources are provided in a chapter-by-chapter format. Simply select the desired chapter from the table of contents. Digital resources are accessed within each chapter via the resources tab.

Once you have created your account, you can use the same email address and password in the future to register any JacarandaPLUS titles you own.

Using eBookPLUS references

eBookPLUS logos are used throughout the printed books to inform you that a digital resource is available to complement the content you are studying.

Searchlight IDs (e.g. **INT-0001**) give you instant access to digital resources. Once you are logged in, simply enter the Searchlight ID for that resource and it will open immediately.

Minimum requirements

JacarandaPLUS requires you to use a supported internet browser and version, otherwise you will not be able to access your resources or view all features and upgrades. The complete list of JacPLUS minimum system requirements can be found at **http://jacplus.desk.com**.

Troubleshooting

- Go to **www.jacplus.com.au** and click on the Help link.
- Visit the JacarandaPLUS Support Centre at **http://jacplus.desk.com** to access a range of step-by-step user guides, ask questions or search for information.
- Contact John Wiley & Sons Australia, Ltd.
  Email: support@jacplus.com.au
  Phone: 1800 JAC PLUS (1800 522 7587)

ACKNOWLEDGEMENTS

The authors and publisher would like to thank the following writers: Anne Dempster, Kingsley Head, Jane Wilson, Kathryn Gibson, Trish Douglas, Terry McMeekin, Elyse Chora, Cleo Westhorpe, Niranjan Casinader, Marilyn Wiber, Kerry Bainbridge, John Ramsdale, Pat Beeson and Alex Rossimel. The authors and publisher would like to thank the following copyright holders, organisations and individuals for their assistance and for permission to reproduce copyright material in this book.

Images

• AAP Newswire: **68**/AP Photo / Genilson Araujo, Agencia O Globo; **112** (right bottom)/Kyodo News; **218**/AAP Image; **318**/EPA/DENNIS M. SABANGAN; **392**(e)/AP Photo/Maritime New Zealand • Adrian Harrison: **341**/© Adrian Harrison • Alamy Australia Pty Ltd: **5** (bottom right)/© geogphotos; **10**, **176**/Pulsar Images; **13** (top)/ton koene; **18**/Patrick Strattner / fStop Images GmbH; **18**/Chris Pancewicz; **26**/© redbrickstock.com; **29**/© Bill Bachman; **41**/© keith morris; **61** (left)/David Mariner; **70** (right)/© aeropix; **81**/Atmotu Images; **86**/National Geographic Image Collection; **92**/National Geographic Creative; **126–127**/Amazon-Images; **138**/imageBROKER; **141**/DEEPU SG; **144**/ Sue Cunningham Photographic; **168**/Doug Steley B; **174**/© Chris Putnam; **190**/© cristian baitg reportage; **192**/Bill Bachman; **202**/© imagebroker; **206** (bottom right)/© Bill Bachmann; **220**(a)/T.M.O.Pictures; **252–253**/david pearson; **262**/Jake Lyell; **264**/David Wall; **332–333**/T.M.O.Travel; **356**/Granger, NYC.; **358**/© RosaIreneBetancourt 7; **372** (right)/© Aurora Photos • Alberta Environments and Parks: **326**/© Copyright 2016, Government of Alberta. • Allianze Global Corporate & Specialty: **389**/Source: Allianz Global Corporate & Specialty Safety and Shipping Review 2016 • Amana Images: **82**, **94**/CORBIS/ Bernard and Catherine Desjeux • Andy Singer: **372** (left)/www.andysinger.com/ • Arizona Exposure Marketing: **53**/Copyright 2016 - Photo courtesy of the Grand Canyon South Rim Chamber of Commerce. • Australian Bureau of Statistics: **418**/Australian Bureau of Statistics, 2011, 2011 Australian Statistical Geography Standard: Remoteness Structure - Remoteness Area Boundaries, Australian Statistical Geography Standard ASGS: Volume 5 - Remoteness Structure, Map, 1270.0.55.005. • Australian Made Campaign Ltd.: **399** • Bathurst Regional Council: **171** • Bureau of Meteorology: **314**, **324** (left) • CartoonStock: **291** • Celeste VanderMey: **79** • Copyright Clearance Center: **289**/Reprinted by permission from Macmillan Publishers Ltd: [Nature] 488, 197–200 August 9, 2012, copyright 2012; **389**/Kaluza, Pablo; Kolzsch, Andrea; Gastner, Michael T.; Blusius, Bernd; The Complex network of global cargo ship movements; Journal of the Royal Society Interface; Figure 1; Page 1094; 2010. • Creative Commons: **6** (top), **382**, **383**, **383**, **383**, **405** (top left), **405** (bottom left)/Department of Foreign Affairs and Trade website – www.dfat.gov.au; **7**/© Commonwealth of Australia. Geoscience Australia 1982; **12**(a)/© National Archives of Australia Aerial view of Port Douglas, Queensland | publication-date=1971 | url=http://trove.nla.gov.au/work/161474801 | accessdate=9 June 2016; **28**(a), **28**(b)/© Commonwealth of Australia Geoscience Australia 2012. This product is released under the Creative Commons Attribution 3.0 Australia Licence.; **43**/Map supplied by MAPLAND, Environmental and Geographic Information, Department for Environment and Heritage, South Australia.; **62**/© Commonwealth of Australia; **65** (bottom), **66**, **170**; **119**/Sourced from Topographic Map 273-09 Egmont. Crown Copyright Reserved. MAPgraphic Pty Ltd, Brisbane; **138**/Wikimedia Commons / http://www.flickr.com/people/82783036@N00; **165**/© Commonwealth of Australia National Archives of Australia 2015.; **214**/© Department of Foreign affairs and Trade; **215**(a)/© AusAID Department of Foreign Affairs and Trade; **243**/© Dept. of Climate Change and Energy Efficiency The Garnaut Climate Change Review 2008, published by the Commonwealth of Australia; **293**/© Coffs Harbour City Council 2014; **342**/Wikimedia Commons / Nick J Webb; **360**/Bureau of Transport Statistics; **365**/© Australian Communications and Media Authority 2014; **370**/Mckinsey Global Institute • Department of Foreign Affairs and Trade: **333**(b)/© Christian James for AusAID Department of Foreign Affairs and Trade website – www.dfat.gov.au • Digital Globe: **8**/Image Courtesy ©2016 Digital Globe • ECCA Nepal: **215**(a) • Esri Australia: **161** • EUMETSAT: **324** (top)/Copyright: 2013 EUMETSAT • Evocities : **169** • Frank R. Rijsberman: **290** • Getty Images Australia: **12**(b)/Peter Harrison; **22** (left)/The Asahi Shimbun; **29** (top)/Kay Dulay; **42**/Portland Press Herald; **51**/Southern Lightscapes-Australia; **59** (bottom)/Bethune Carmichael; **61** (right)/Thorsten Blackwood; **78**, **82**/© Mlenny; **82**/Konrad Wothe / LOOK-foto; **91**(a)/MDA INFORMATION SYSTEMS; **107**/© guenterguni; **140**/Auscape/UIG; **144**/RAUL ARBOLEDA / AFP; **144**/James P. Blair / National Geographic; **154–155**/btrenkel; **180**(a)/Martin Cohen Wild About Australia; **189**/Bloomberg; **195**/Ezra Shaw; **215**(b)/ Kaveh Kazemi; **255**/Peter Walton Photography; **258**/TIMUR MATAHARI; **260**/ChinaFotoPress; **260**/Stuart Jenner; **260**/ADALBERTO ROQUE/AFP; **265**/TED MEAD; **274**/Istimages; **274**/Peter Harrison; **282**/DEA / PUBBLI AER FOTO; **283**/M Swiet Production; **283**/Dan Kamminga; **286**/Karen Kasmauski; **294**/TORSTEN BLACKWOOD; **305**/AFP; **309**/ VANDERLEI ALMEIDA; **311**/MUNIR UZ ZAMAN; **319** (top)/Kevin Frayer; **319** (left), **319** (right)/DigitalGlobe; **325** (bottom left)/MADAREE TOHLALA/AFP; **328**/Martin Shields; **333**(f)/Michelle Shephard; **342**/William West/ AFP; **348**/Red Huber/Orlando Sentinel/MCT; **372**/Chesnot; **400**/HOANG DINH NAM/AFP; **405** (top right)/JAY DIRECTO/AFP; **421**/Alvin J. Baez-Hernandez/ASAblanca • Global Goals: **404** • Grant Gibbs: **215**(b)/© Grant Gibbs www.hipporoller.org • HMFD: **377** • International Telecommunication Union ITU: **199** • iStockphoto: **2** (globe)/ scanrail • IWMI: **288**/Used under license from IWMI • Johnny Haglund: **283** • Judy Mraz: **89**, **237** • Karen Bowden: **5** (bottom left), **161**, **161**, **162**; **171**, **377**, **390**, **392**(a), **393**, **424**, **425** • Land and Property Information : **359** • Land

and Property Management Authority NSW: **71** • Louise Swanson: **248**; **269**, **270** (top left), **270** (top right), **270** (middle left), **270** (middle right), **270** (bottom left), **270** (bottom middle), **270** (bottom right), **278**, **298** (left), **298** (center), **298** (right) • Malum Nalu: **219** • ManatuTaonga Ministry for Culture and Heritage: **234**/Reproduced from Te Ara, the Encyclopedia of New Zealand http://www.teara.govt.nz • MAPgraphics: **28**, **29** (left), **74**, **95**, **128**, **134**, **135**, **137**, **138**, **187**, **197**, **246**, **278**, **302**/MAPgraphics Pty Ltd, Brisbane; **143**/Hugo Ahlenius, UNEP/GRID-Arendal http://www.grida.no/graphicslib/detail/extent-of-deforestation-in-borneo-1950-2005-and-projection-towards-2020_119c; **148**/Commonwealth of Australia – Geoscience Australia; **149**/Commonwealth of Australia – Geoscience; **313**/US Geological Survey. Redrawn by MAPgraphics Pty Ltd, Brisbane • Mark Lincoln: **116** • Matt Krueger: **413** • Michael Amendolia: **88** • Mihi Digital: **368** • NASA: **316**, **324** (right) • NASA - JPL: **118**/Image Science and Analysis Laboratory, NASA-Johnson Space Center; **303** (top right), **307**(a), **307**(b)/Courtesy NASA/JPL-Caltech. • National Geographic: **204–205**/Randy Olson • NBN Co: **417** • Newspix: **67**/David Crosling; **135**/Anna Rogers; **167**/ Stephen Cooper; **172**/Bob Barker; **207** (bottom right)/News Ltd / Phil Hillyard; **306**/David Martinelli; **308**; **311**/David Kapernick; **314**/John Grainger; **325** (top right)/John Grainger; **426**/Marc McCormack • Nicole Ford: **132** • Niranjan Casinader: **176** • NIWA New Zealand: **248**/NIWA Taihoro Nukurangi www.niwa.co.nz • NSW Ministry of Health: **194**/Reproduced by permission, NSW Ministry of Health © 2016 • OECD: **403**/OECD 2014, Development aid stable in 2014 but flows to poorest countries still falling, http://www.oecd.org/dac/stats/development-aid-stable-in-2014-but-flows-to-poorest-countries-still-falling.htm • Out of Copyright: **167** • Panos Pictures: **406–407**/ Andrew McConnell • Pew Research Center: **409**/"Cell Phones in Africa: Communication Lifeline" Pew Research Center, Washington, DC April, 2015 http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/ • PhotoDisc, Inc.: **147** • Picture Media: **282** • Public Domain: **108**/US Geological Survey; **214**, **409**; **367**/http://data.worldbank.org/indicator/IT.NET.USER.P2, "The World Bank Group authorizes the use of this material subject to the terms and conditions on its website, http://www.worldbank.org/terms." • Saxo Bank A/S: **341** • Shutterstock: **2** (mountains)/Honza Krej; **2** (boy)/john austin; **2** (domes)/Janelle Lugge; **2** (water)/Willyam Bradberry; **2** (market)/ Adisa; **2** (garbage)/think4photop; **2** (temple)/Alexander Smulskiy; **9**/Christian Draghici; **16** (left)/racorn; **16** (right)/ parinyabinsuk; **17**(a)/Toa55; **17**(b)/light poet; **17**(c)/bikeriderlondon; **17**(d)/Georgejmclittle; **17**(e), **258**, **329**/goodluz; **20–21**/Honza Krej; **20–21**/Neale Cousland; **20–21**, **96–97**/Dominik Michalek; **22–23**/totajla; **24**, **101**/Daniel Prudek; **25**, **35**/© Jason Patrick Ross; **33**/© Sarah Fields Photography; **33**/Yuri Kravchenko; **35**/© Alberto Loyo; **37**/© Giancarlo Liguori; **46–47**/Rat007; **48** (left)/Olga Danylenko; **52**, **86**, **99** (bottom)/goodluz; **59** (top), **379**/Stanislav Fosenbauer; **63** (bottom)/Alister G Jupp; **64** (left)/John Carnemolla; **65** (top), **164**(d)/AJP; **70** (left)/mark higgins; **72–73**/Sourav and Joyeeta; **75** (top)/linma; **75** (bottom)/Eniko Balogh; **77**/Roberto Caucino; **79**, **129**/ AustralianCamera; **79**/Armin Rose; **84**/Christopher Halloran; **85**/Janelle Lugge; **86**/N Mrtgh; **52**, **86**, **99** (bottom)/ Goodluz; **90**, **371**/LUCARELLI TEMISTOCLE; **91** (b)/© Tim Roberts Photography; **101**/© col; **101**/THPStock; **102**/Sean Pavone; **102**/© Craig Hanson; **102**/f9photos; **107**/© John A Cameron; **109**/© Francesco Carucci; **111**/ Dutourdumonde Photography; **118**/© bartuchna@yahoo.pl; **123** (bottom)/Jordan Lye; **129**/Ashley Whitworth; **129**/ Paulo Vilela; **132**/clearviewstock; **137**/Amy Nichole Harris; **140**/YIFANG NIE; **140**/Dr. Morley Read; **142**/Kjersti Joergensen; **145**/Txanbelin; **150**/Dmitry Naumov; **151**/Brisbane; **152–153**/jan kranendonk; **156** (top left), **185**(l)/ leoks; **156** (top right)/Corepics VOF; **156** (bottom)/Panos Karas; **157** (top left)/S.Borisov; **157** (top right)/T photography; **157** (middle left), **274**/EpicStockMedia; **157** (middle right)/Alexandra Lande; **157** (bottom left)/ Ekaterina Pokrovsky; **157** (bottom right)/Sufi; **164**(a)/qingqing; **164**(b)/Ivonne Wierink; **164**(c), **392**(c)/NigelSpiers; **170**/Federico Rostagno; **170**/zstock; **170**/YanLev; **175**/Antoine Beyeler; **175**/Pavel L Photo and Video; **179**/Nicolesa; **181**(c)/Perig; **182**(d)/Dan Breckwoldt; **182**(e)/LingHK; **184**(a)/Vladimir Melnik; **184**(b)/Anki Hoglund; **184**(c)/ Francesco R. Iacomino; **184**(d)/haveseen; **184**(d), **185**(j)/Andrey Bayda; **185**(e)/Mohamed Shareef; **185**(f)/Jane Rix; **185**(g)/JeniFoto; **185**(h)/Vladimir Melnik; **185**(i)/Nickolay Vinokurov; **185**(k)/Aleksandar Todorovic; **185**(m)/ Alexander Chaikin; **185**(n)/stocker1970; **185**(o)/Kenneth Dedeu; **190**/Dmitry Kalinovsky; **190**, **245** (left top), **379**/ Nils Versemann; **197**/ollirg; **198**/windmoon; **198**/Kim Britten; **199**/Luciano Mortula; **199**/Marina99; **199**/ VLADGRIN; **200**/David Pereiras; **200**/Nicholas Rjabow; **206** (top left)/Kirayonak Yuliya; **206** (top right)/ DiversityStudio; **206** (bottom left)/Mihail Semenov; **207** (top left)/Phovoir; **207** (top right)/© Martin Allinger; **207** (bottom left)/ Blend Images; **207** (bottom middle)/© studioflara; **220**(b)/ISchmidt; **223** (bottom)/Diego Cervo; **224** (top)/PomInOz; **224** (bottom)/kittis; **226** (left)/Ivelin Radkov; **226** (right)/kurhan; **228–229**/Caleb Foster; **230–231**/ Photobank gallery; **232** (left), **258**/Monkey Business Images; **232** (right top)/freya-photographer; **232** (right middle)/ WitthayaP; **232** (right bottom)/Catalin Petolea; **233**(a)/18042011; **245** (left middle)/Martin Valigursky; **245** (left bottom)/Jiratsung; **250**/Sara Winter; **268**/dedoma; **269**(a)/BlueOrange Studio; **269**(b)/leungchopan; **272**/© Africa Studio; **276–277**, **288**/Juan A. Salgado; **283**/Nikola Bilic; **284**/Gimas; **285**(a)/grafvision; **285**(b)/Kathie Nichols; **285**(c)/InnaFelker; **292**/africa924; **292**/Artush; **300–301**/Minerva Studio; **303** (top left)/swa182; **303** (bottom right)/ jaddingt; **303** (bottom left)/mapichai; **311**/yampi; **313**/Matt Jeppson; **317**/ausnewsde; **321**/Richard A McMillin; **322**/ Manon van Os; **325** (top left)/glenda; **325** (bottom right)/Leremy; **17**(e), **258**, **329**/Goodluz; **330–331**/Anton Balazh; **333**(a)/Gurgen Bakhshetsyan; **333**(c), **354–355**/Supphachai Salaeman; **333**(d)/luchunyu; **333**(e)/Dudarev Mikhail; **335**/AVAVA; **338**/Lucky Business; **343**/123Nelson; **352**/e2dan; **356**/Sorbis; **356**/Taina Sohlman; **357**/Oliver Hoffmann; **366**/bloomua; **370**/Philll; **377**(a)/Jimmy Tran; **377**(b)/TFoxFoto; **377**(c)/monticello; **377**(d)/StudioSmart; **378**/Irina Borsuchenko; **381**(a), **381**(f)/© Pressmaster; **381**(b)/© bikeriderlondon; **381**(c)/© nikkytok; **381**(d)/© Levent Konuk; **381**(e)/© Amanda Sutcliffe; **381**(g)/© Goodluz; **390**/VladSV; **391**/phadungsak sawasdee; **392**(b)/ anekoho; **392**(d)/Steve Meese; **392**(f)/Eugene Sergeev; **394**/superjoseph; **394**/EQRoy; **397**/Antonio-BanderAS; **397**/ remik44992; **398**/supergenijalac; **398**/Matt Ragen; **399**/testing; **400**/a katz; **401**/SeeVera; **412**/Rawpixel.com; **414**/

Mark52; **416**/cigdem; **419**/asharkyu; **422**/rezachka; **426**/Budimir Jevtic; **429**/gopixa; **430**/Russell Shively; **431**, **431**/Zastolskiy Victor • Snamuts: **363** • Spatial Vision: **4**, **9** (left), **9** (right), **11**, **15**, **18** (left), **18** (right), **27**, **29** (right), **43**, **50**, **85**, **87**, **111**, **114**, **112**, **143**, **160**, **160**, **166**, **166**, **167**, **173**, **174**, **180**, **181**(b), **192**, **194**, **218**, **248**, **249**, **254**, **263**, **268**, **273**, **280**, **280**(a), **285**, **295**, **299**, **315**, **326**, **334**, **338**, **344**, **353**, **382**, **384**, **391**, **394**, **395**, **396**, **397**, **400**, **408**, **408**, **414** (top left), **427**; **5** (top)/Data from World Trade Organization. Map by Spatial Vision.; **38** (bottom)/Source: World Map of Carbonate Rock Outcrops v3.0. Map created by Spatial Vision; **56**/NPWS data 2012 and Forests NSW data 2011; **98**/http://store.mapsofworld.com/-c-3380/digital-map-of-major-mountain-peaks-of-the-world; **104**, **106**, **112** (right top), **118**, **275**; **163** / Australian Bureau of Statistics 2012; **177**/ David R Horton, creator, published by Aboriginal Studies Press / AIATSIS and Auslig/ Sinclair, Knight Merz 1996.; **192**/ Australian Bureau of Statistics; **201**, **262**, **294**/Natural Earth Data; **214**, **217**/Geoscience Australia; **238**/BGR & UNESCO 2008: Groundwater Resources of the World 1 : 25 000 000. Hannover, Paris. was: data copyright 2012 WHYMAP / Map redrawn by Spatial Vision; **261**/Data © Copyright World Health Organisation WHO, 2012. All rights Reserved.; **262**/© Data sourced from World Health Organisation 2012 / Redrawn by Spatial Vision; **264**/Redrawn with permission from the SA Arid Lands Natural Resources Management Board / © Copyright Commonwealth of Australia Geoscience Australia 2006; **265**, **266**/ Geoscience Australia; **280**, **280**/Bureau of Meterology; **309**/Natural Earth Data; **321**/North Carolina Floodplain Mapping Program; **361** (left), **361** (right)/Data from Sydney Alliance Transport Team: Kurt Iveson & Laurence Troy, University of Sydney. Map drawn by Spatial Vision.; **365**/Data by Greg Mahlknecht, www.cablemap.info. Map drawn by Spatial Vision.; **376**/Data from Wikmedia Commons, User: Steff. Map drawn by Spatial Vision.; **402**/Data from Fairtrade International. Map drawn by Spatial Vision.; **404**/Data from Australian Bureau of Statistics Year Book Australia, 2012, cat. no. 1301.0, ABS, Canberra & United Nations Development Programme. Map drawn by Spatial Vision.; **421**/Data from Greenpeace. Map drawn by Spatial Vision. • Steven Newman: **48** (right), **49**, **49**, **57**, **63** (top), **63** (middle), **64** (right), **68**, **70** (top) • Susan Caldis: **103**, **103**/Reprinted with permission of John Wiley & Sons, Inc. • The Economist: **212** • The World Bank: **367**, **368** • Thomas L. Kelly: **290** • Tom Perry: **405** (bottom right) • Transport for NSW: **379** • TSRA : **216**/TSRA • UNESCO: **55** • University of the South: **215**(c)/Photo as taken by L.Limalevu PACE-SD. • UNWTO: **6** (bottom), **339**, **339**, **349**; **334**, **335**/© UNWTO, 9284401613 / UNWTO Tourism Highlights, 2012 Edition • USAID: **318**/Typhoon Yolanda - USAID/OFDA Interactive Fact Sheet • We Are Social: **369**/We Are Social analysis of Facebook data, Q1 2015, latest company statements correct as of 17 January 2015 • West Australian Football Commission: **192** • WFTO-SA: **402**(a), **402**(b), **402**(c), **402**(d)/Images courtesy of World Fair Trade Organization South Africa WFTO-SA • World Bank: **323**/World Bank, 2015.; **414** (top right)/World Bank, 2010. • World Trade Organization: **389**

Text

• NSW Geography K–10 Syllabus © 2016 Copyright Board of Studies, Teaching and Educational Standards New South Wales for and on behalf of the Crown in right of the State of New South Wales, 2017 • Beryl Carmichael: **50–51**/The Australian Museum, www.dreamtime.net.au/creation • Curtis Brown Aus: **48**/The Licensor will be credited in due prominence. The Licensee shall ensure that the text: By Arrangement with the Licensor, The Dorothea Mackellae Estate • NSW Ministry of Health: **195**/Reproduced by permission, NSW Ministry of Health © 2016 • Sensis : **370**/"Reproduced with the permission of Sensis Pty Ltd." • Snamuts: **362** • The Economist: **209**
• UNESCO: **55**

Every effort has been made to trace the ownership of copyright material. Information that will enable the publisher to rectify any error or omission in subsequent reprints will be welcome. In such cases, please contact the Permissions Section of John Wiley & Sons Australia, Ltd.

1.1 Overview

1.1.1 What is a geographical inquiry?

The world around us is made up of interesting places, people, cultures and environments. Geography is the subject that you study at school to learn about different places, and how relationships between environments and people shape these places. Geographers question how environments functions and why the world is the way it is. They explore geographic issues and challenges facing us today, predict outcomes and come up with possible solutions for the future. Geographers are active and responsible citizens, who are informed about our world and are capable of shaping the future.



FIGURE 1 Our planet is made up of a large variety of fascinating places, peoples, cultures and environments.

Have you ever visited or gone on holidays to a place other than where you live? If so you have probably noticed that some of the features and characteristics of the people and places are similar and some are different. Studying Geography at school provides you with the skills, the knowledge

and the tools to learn about and understand the relationships between the world's people, places and environments.

As a geographer you get to ask questions and then seek to answer them. Geographers use what is called an inquiry approach to help them learn about and understand the world around them. This could involve you working individually, or as part of a group, to discover the answer to a geographical question, using a variety of geographical skills, tools and concepts.

Geographers also look at many interesting issues which face the world today; for example, different people have different viewpoints, or perspectives, about what we should do about climate change. The answer to this question might vary for an individual, a local area, a country, or even on a world scale.

1.1.2 What are inquiry skills?

Have you ever noticed that young children ask many questions as they begin to learn because they are curious about the world around them? Below are some examples of questions which we can call *geographical* questions:

- Why are there many different types of landscapes around the world and how are they formed?
- Where is the best place to live?
- How can we look after our water resources so we have enough for the future?
- What are the effects of tourism in different places?

Geographical inquiry skills develop your ability to collect, process and communicate information.

Acquiring geographical information

Acquiring or collecting geographical information needs to be focused and well planned. Begin a geographical inquiry by developing a problem or issue to investigate. This will be the general theme of your inquiry. Develop a few geographical questions that will help you study your issue or problem. Ensure that your questions are not so broad that they will be difficult to investigate, for example water management in Australia, or so specific that you won't be able to find enough information to support your inquiry.

Think about how you will collect information about your inquiry. You should include both primary geographical data and information from secondary sources. Primary data is information that you have collected yourself using fieldwork. Secondary sources are data that has been collected and processed by someone else, or written by someone else. Secondary sources include websites, books and brochures. Once you have decided on the information you need, plan your investigation and carry out your fieldwork and collate information from secondary sources.

Processing geographical information

Before you begin processing the information you have collected, you should evaluate the sources and techniques you have used to determine whether they are reliable and free from bias. Can you trust the sources of information? Did you carry out your fieldwork techniques thoroughly and with care? Present your information in a range of different forms. This might include graphs, tables, diagrams, sketch maps and annotated photographs. You might also write paragraphs explaining your results. Look at the information you have collected and reflect on your research questions. At this stage you can start to interpret the information. Did you answer your research questions? What are the answers to your research questions? Analyse the findings of your research and draw conclusions.

Communicating geographical information

You can choose to communicate your research findings in a range of ways. Consider who you will be presenting your findings to. Choose methods to communicate your information that are appropriate to your audience. Explain how you undertook your investigation and your findings. Propose actions that you think should be taken to address your problem or issue, and explain why you think this is the right course of action. If possible, take action yourself to address the geographical issue you have chosen.

1.1.3 What are geographical tools?

Geographers use a range of tools to help them collect information during a geographical inquiry. Geographical tools include:

- maps
- fieldwork
- graphs and statistics
- spatial technologies
- visual representations.

Maps

Maps are the most basic tool of the geographer as they are possibly the most effective way to locate, represent, display and record spatial information. These days, geographers are able to use, and create, both digital and non-digital maps.

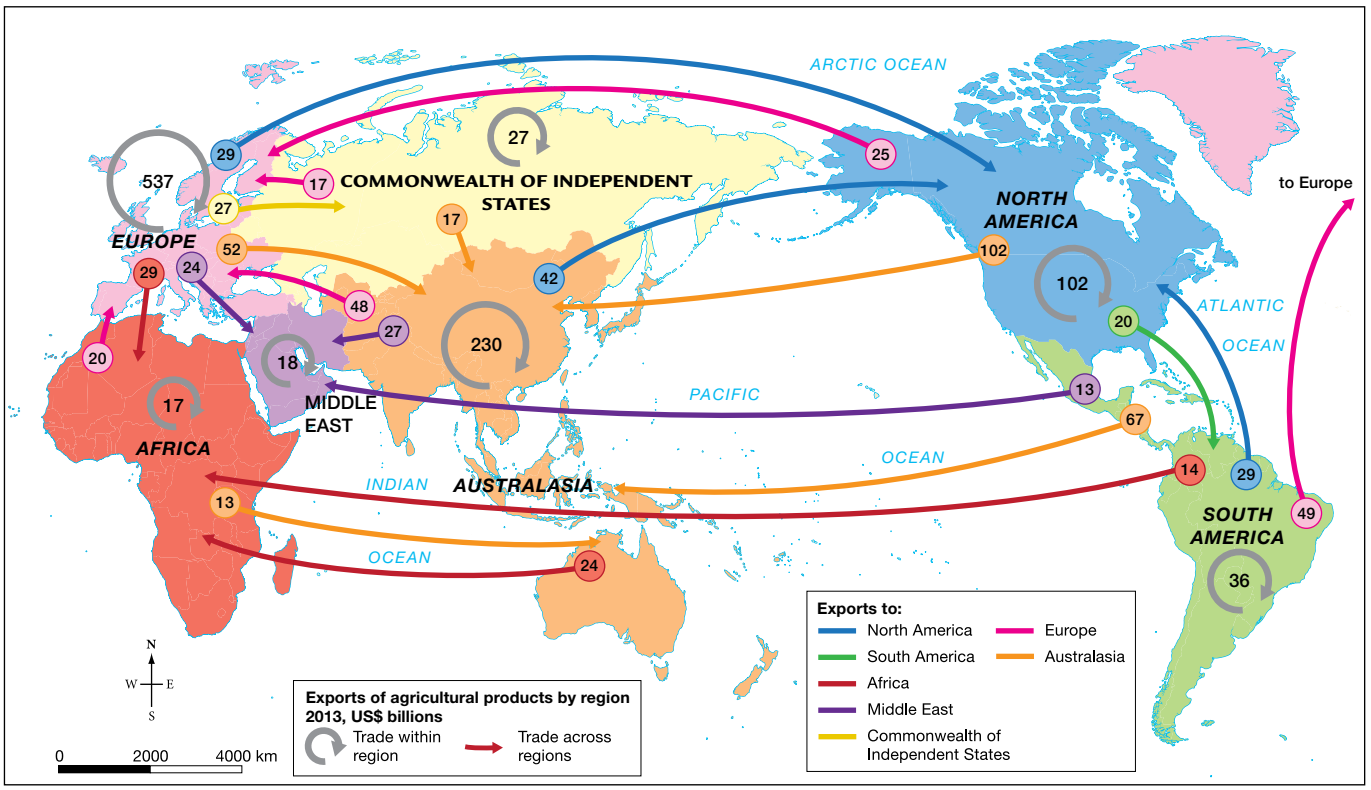
Political maps are common; they show the boundaries of countries, states and regions, and usually show major cities and bodies of water. Topographic maps and relief maps show the shape of the land on a map. Sketch maps are hand drawn maps which show only the most basic details. Maps can be used to show information about particular themes, such as choropleth maps or flowline maps. Precis maps show a basic summary of information found on a topographic map.

FIGURE 2 A political map of Africa showing the boundaries of countries



Source: Spatial Vision

FIGURE 3 A flow line map shows the movement of oil trade around the world.



Source: Spatial Vision

It is important for geographers to develop skills in map reading to be able to use all the information found. Mapping skills include being able to determine direction and use the scale of the map to determine distance between different places. Geographers use lines drawn on maps to determine and communicate the location of different places. On topographic maps, grids are used to determine the area and grid reference of different places. On some maps lines of latitude and longitude are shown to help us locate places.

Fieldwork

There is nothing better than going into an environment, or to visit a place, that you are studying. Seeing something first-hand provides a better understanding than reading about it or looking at it in photographs. That is why fieldwork is such an important, and compulsory, part of your studies.

Fieldwork involves observing, measuring, collecting and recording information and data outside the classroom.

FIGURE 4 Conducting a survey in the field



FIGURE 5 Collecting your own data and information



Fieldwork can be undertaken within the school grounds, around the local neighbouring area or at more distant locations. We can use tools such as weather instruments, identification charts, photographs and measuring devices to collect information about our environment.

Sometimes it may be necessary to use information and communication technology to undertake virtual fieldwork.

Graphs and statistics

Often geographers collect information as numbers. Examples include traffic counts and surveys. These numbers are called statistics. On a field trip you might count the number of pedestrians on a footpath in a given period of time. Statistics which are collected and not processed or analysed yet are called primary data. Statistics which have been processed or analysed by someone are called secondary data.

A simple and effective way geographers present statistics or data is through the use of graphs. There are many different types of graphs that can be used. The most common types of graphs you will use in this resource are column graphs, pie graphs, climate graphs, population profiles and data tables.

Graphs and statistics allow us to easily identify trends and patterns and to make comparisons.

Using statistics helps us to find patterns in the information we have collected. This will help us to draw conclusions about the themes we have investigated.

FIGURE 6 Australia's leading exports of goods and services in A$ million

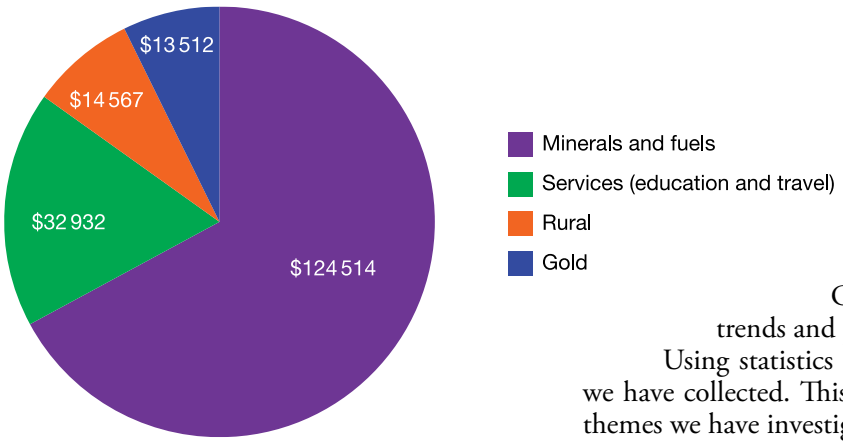
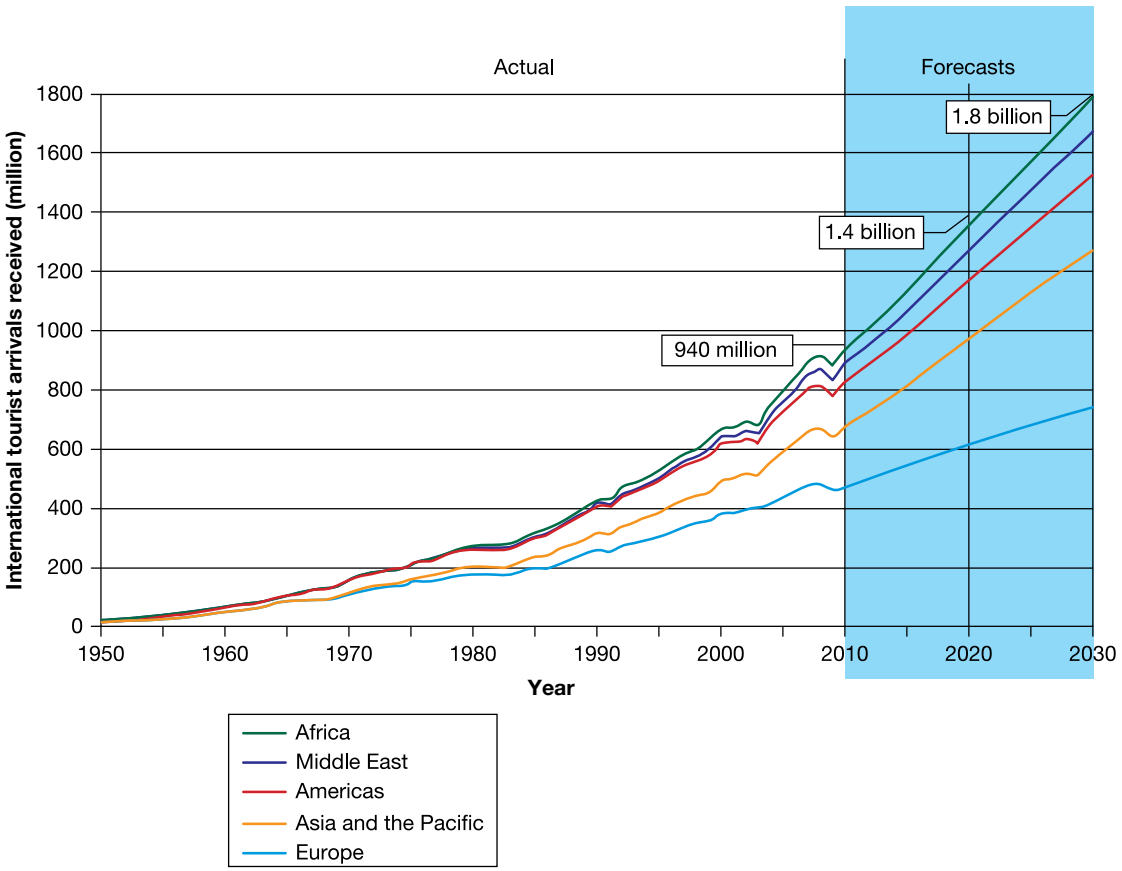


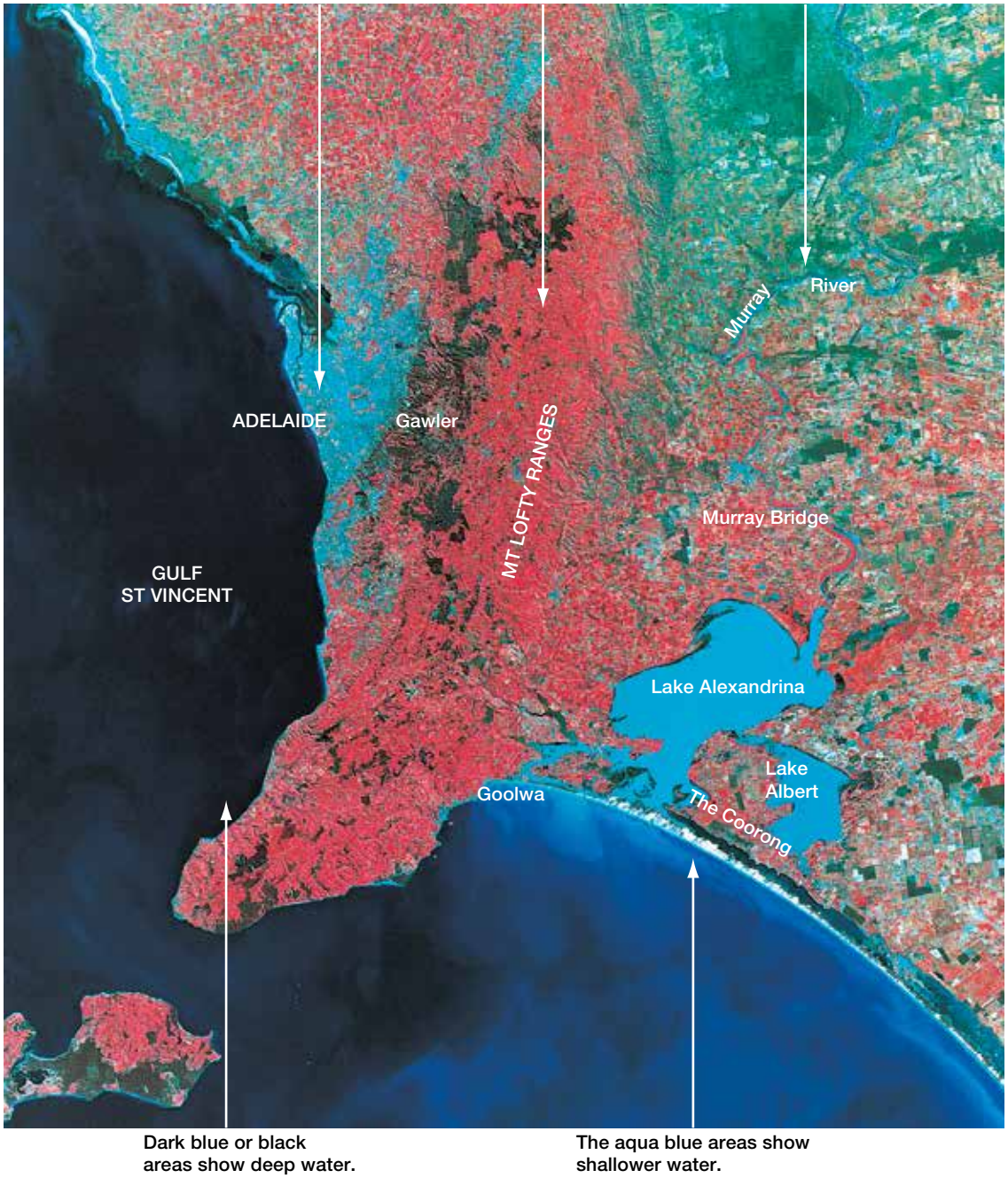
FIGURE 7 Trends and forecasts in tourist arrivals



Spatial technologies

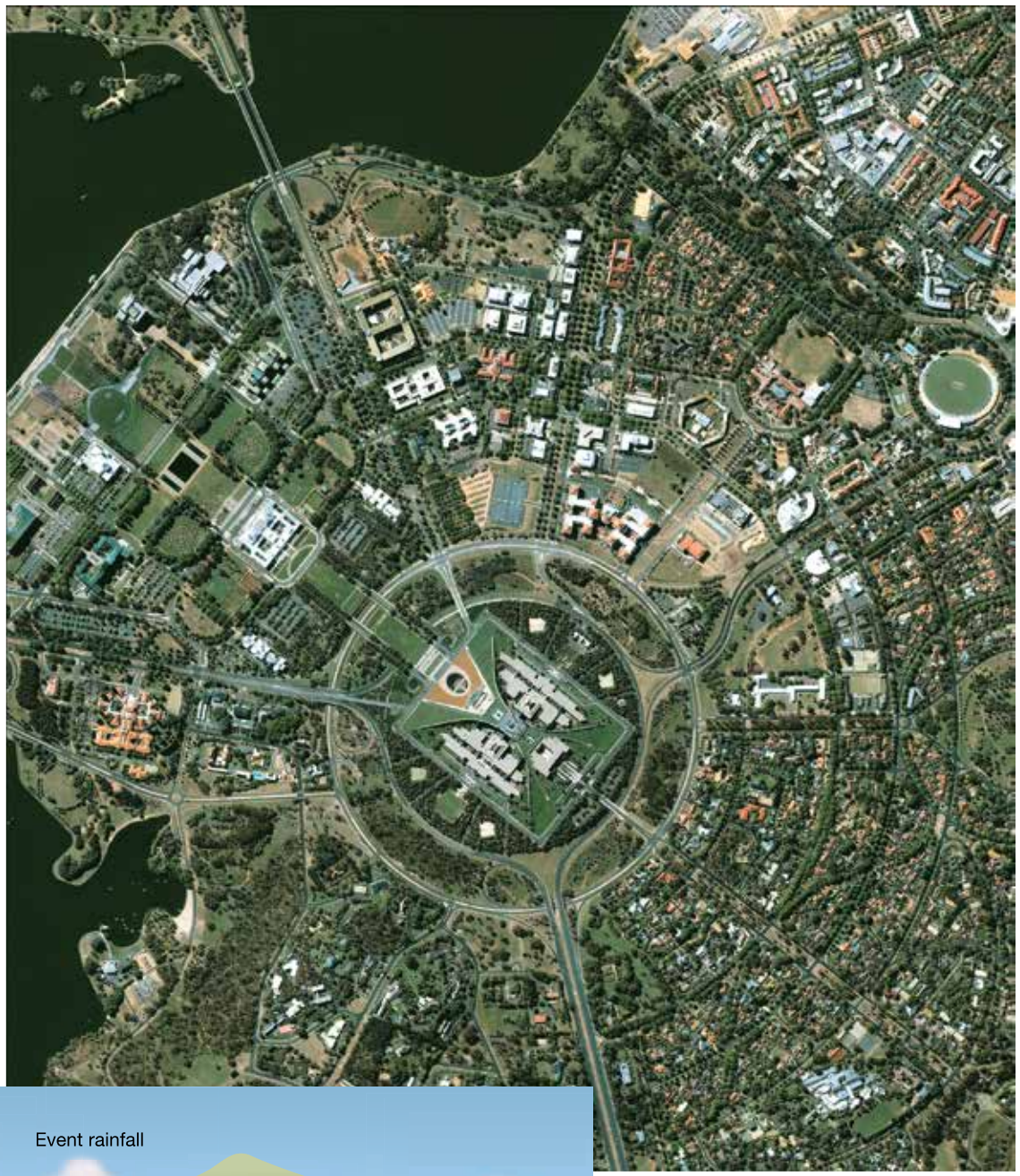
Spatial technologies involve using satellite information and virtual maps to explore and record information. When you use Global Positioning System (GPS) or Google Earth you are using a form of spatial technology. Spatial technologies are any software or hardware that interact with real-world locations. Geographic information systems (GIS) are another commonly used spatial technologies. They help us analyse, display and record spatial data.

FIGURE 8 A false-colour satellite image of the Mt Lofty Ranges

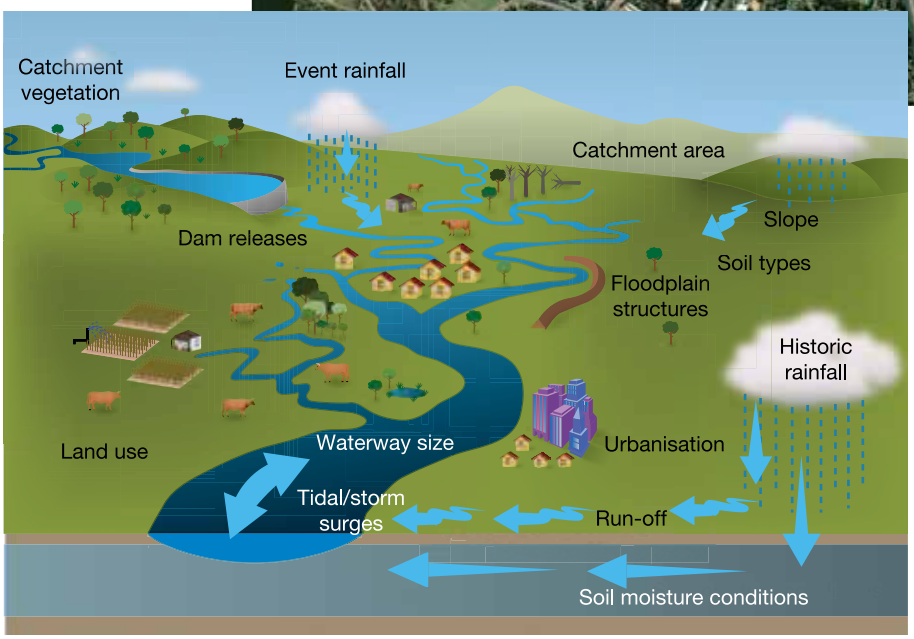


Source: © Commonwealth of Australia. Geoscience Australia 1982.

FIGURE 9 Satellite image of Canberra, by GeoEye, 26 September 2011. Satellite images show a realistic view like a photograph, providing a birds-eye view of a place.



Source: © GeoEye



Visual representations

A visual representation is an effective way of showing complex information using pictures, symbols and diagrams. Examples of visual representations include photographs, field sketches, cartoons and infographics. They are used to display, analyse and communicate geographical data and information.

FIGURE 10 This visual representation of the water cycle and factors that affect flooding includes information and images to help you understand geographical processes.

1.2 Geographical concepts

1.2.1 Overview

Geographical concepts help you to make sense of your world. By using these concepts you can both investigate and understand the world you live in, and you can use them to try to imagine a different world. The concepts help you to think geographically. There are seven major concepts: ***space***, ***place***, ***interconnection***, ***change***, ***environment***, ***sustainability*** and ***scale***.



A way to remember these seven concepts is to think of the term SPICESS.

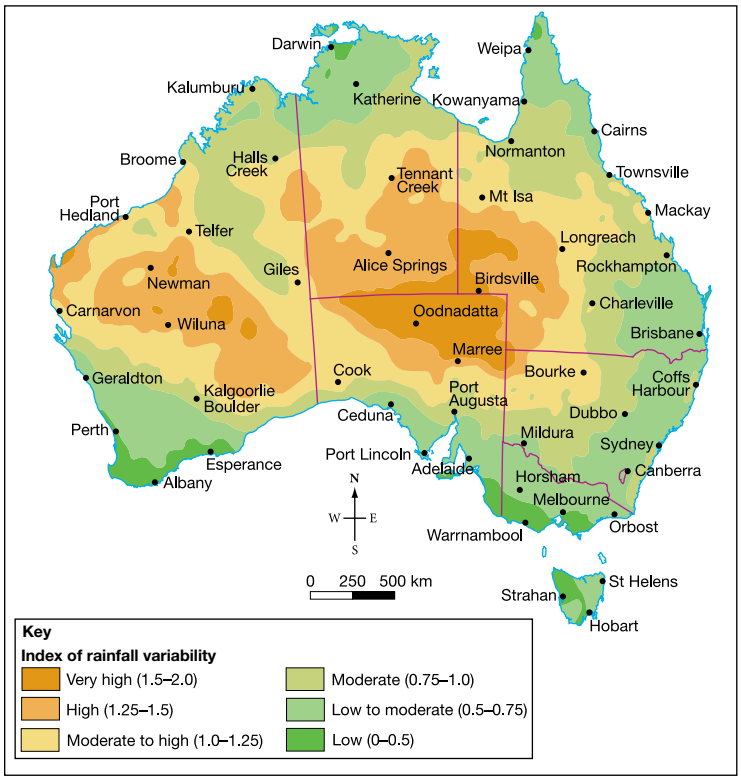
In this book, you will use and apply the seven concepts to investigate four topics: *Landscapes and landforms, Place and liveability, Water in the world* and *Interconnections.*

1.2.2 What is space?

Everything has a location on the space that is the surface of the Earth, and studying the effects of location, the distribution of things across this space, and how the space is organised and managed by people, helps us to understand why the world is like it is.

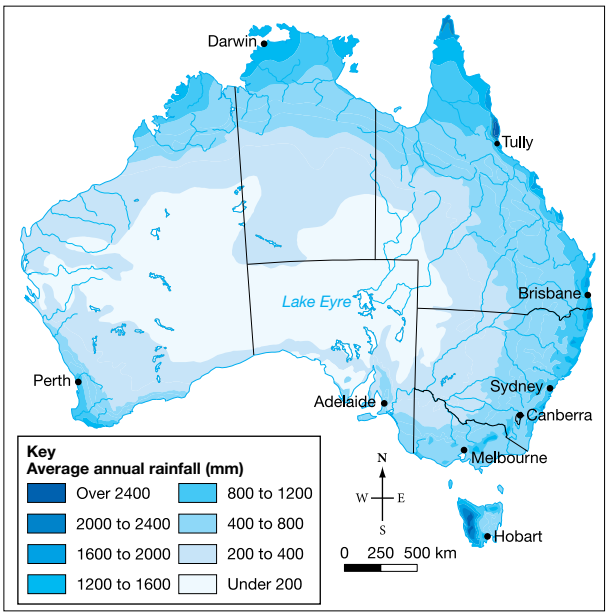
A place can be described by its absolute location (latitude and longitude) or its relative location (in what direction and how far it is from another place).

FIGURE 1 Australian annual rainfall variability, 1900–2003



Source: © Spatial Vision

FIGURE 2 The amount of rain that falls in Australia varies from place to place, as this rainfall map shows.



Source: Spatial Vision

ACTIVITIES

Refer to figures 1 and 2.

1. Use an atlas to give the absolute location (latitude and longitude) of the capital city of the state/territory in which you live.
2. In which direction and how far is your capital city from Alice Springs (relative location)?
3. Describe the ***spatial*** distribution of capital cities in Australia.
4. Describe the distribution of rainfall across Australia. Why might one ***place*** have more or less rainfall than another?
5. How does rainfall (or lack of rainfall) help explain the distribution of Australia's major cities? What is the relationship between rainfall and population location?
6. Find where you live on the maps. How is the location of your ***place*** influenced by rainfall and rainfall variability?

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Space

1.2.3 What is place?

The world is made up of places, so to understand our world we need to understand its places by studying their variety, how they influence our lives and how we create and change them.

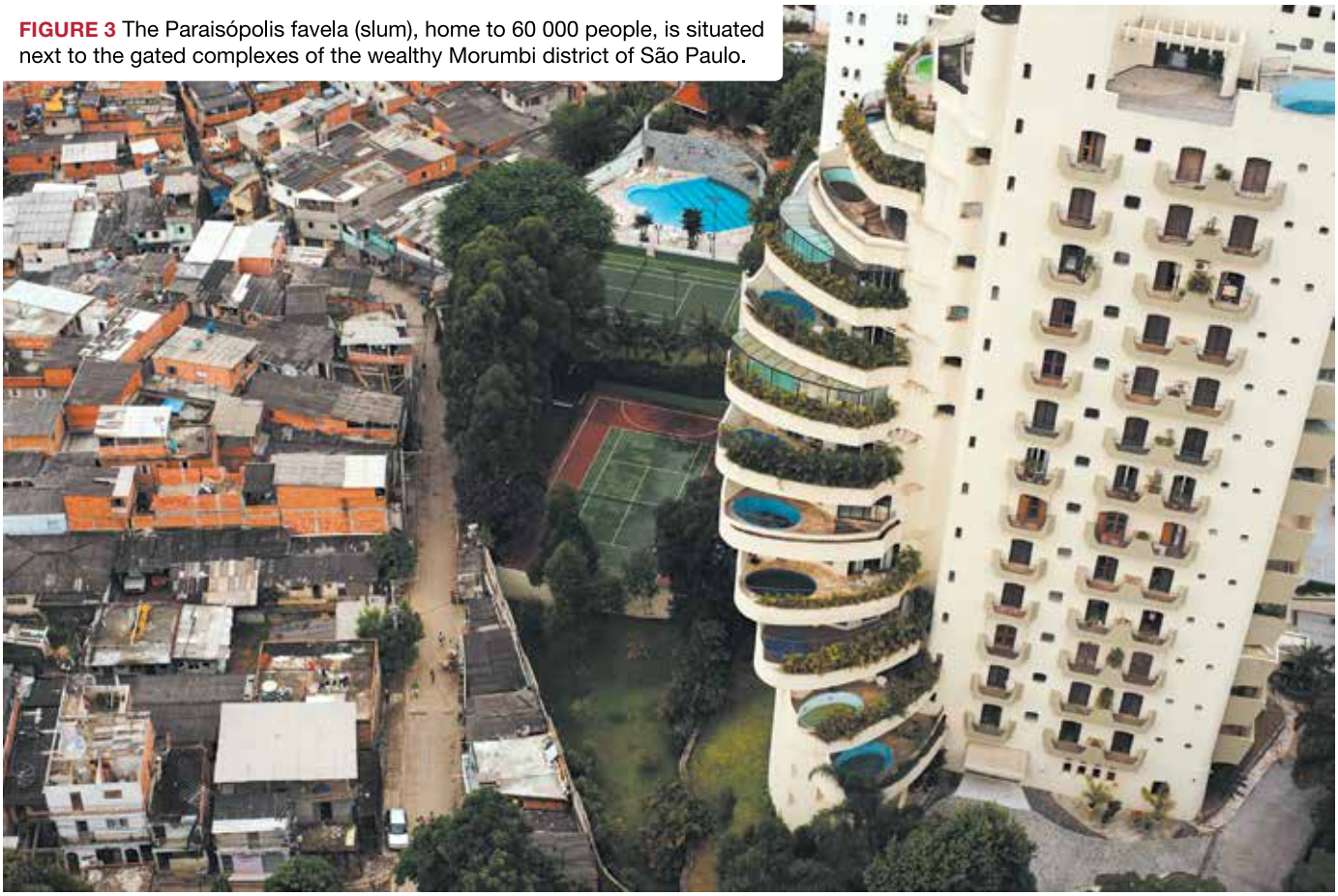
You often have mental images and perceptions of *places* — rich and poor cities, suburbs, towns or neighbourhoods — and these may be very different from someone else's perceptions of the same *places*.

ACTIVITIES

Refer to figure 3.

1. Where in the world is this ***place*** located?
2. What effects have people had on this ***place***?
3. List the differences you observe in the way people live on each side of this settlement.
4. How is this ***place*** similar to or different from the ***place*** where you live?
5. What decisions could be made to improve or ***change*** this ***place***?
6. How might the ***environment*** of this ***place*** affect the people who live there?
7. How does the ***place*** where these people live affect their lives?

FIGURE 3 The Paraisópolis favela (slum), home to 60 000 people, is situated next to the gated complexes of the wealthy Morumbi district of São Paulo.



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Place

1.2.4 What is interconnection?

People and things are connected to other people and things in their own and other places, and understanding these connections helps us to understand how and why places are changing.

Individual geographical features can be interconnected — for example, the climate within a place or biome, such as a tropical rainforest, can influence natural vegetation, while removal of this vegetation can affect climate. People can be interconnected to other people and other places via employment, communications, sporting events or culturally. The manufacturing of a product may create interconnections between suppliers, manufacturers, retailers and consumers.



Source: Spatial Vision

FIGURE 4 Many countries have strict laws dealing with e-waste disposal. It is often easier to export the material to countries in South-East Asia, where there are fewer laws and the wastes can be broken down, recycled or sold. It is extremely hazardous.

ACTIVITIES

Refer to figure 4.

1. Describe the distribution of the main ports dealing with e-waste trade.
2. What is the ***interconnection*** between the main recycling countries and the main ports that receive and dispatch e-waste?
3. Describe the ***interconnection*** between North America and Asia in relation to e-waste trade.
4. Create a diagram to show the ***interconnections*** that could occur for the growing, manufacturing, sales and consumption of a can of pineapple slices.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Interconnection

1.2.5 What is change?

The concept of change is about using time to better understand a place, an environment, a spatial pattern or a geographical problem.

The concept of change involves both time and space — change can take place over a period of time, or over an area. The time period for change can be very short (for example, the impact of a flash flood) or over thousands or millions of years (for example, the development of fossil fuel resources).

Environmental change can occur over short or long periods of time. The use of technology can result in rapid change — think of the explosions at a mining site that reveal mineral seams.

The degree of change occurring can be used to predict, or plan for, actual or preferred futures.

FIGURE 5 Port Douglas, 60 kilometres north of Cairns, was a busy port in the 1870s, with a population over 10 000. The mining that had attracted people to this hot, wet area did not last. By the 1960s, the population was only 100. In the 1980s, road and air access to the town improved and tourist numbers to the area grew. The permanent population is now about 1300. During the peak holiday season (May to November), this number increases by four times.

(a) 1971



(b) 2009



ACTIVITIES

Refer to figure 5.

1. How and why has the population of Port Douglas ***changed*** over time?
2. Which economies have declined and grown in the Port Douglas area?
3. How has technology (transport links) been important in the development of this ***place***?
4. How do you think the ***changes*** have affected the ***environment***, businesses and economy in the area?
5. List five ***changes*** you can observe in the two photographs of Port Douglas.
6. Use evidence from the photographs to decide if the natural ***environment*** has changed faster than the human ***environment***.
7. What is your preferred future for this ***place***? What ***changes*** need to occur for your preferred future to come about?

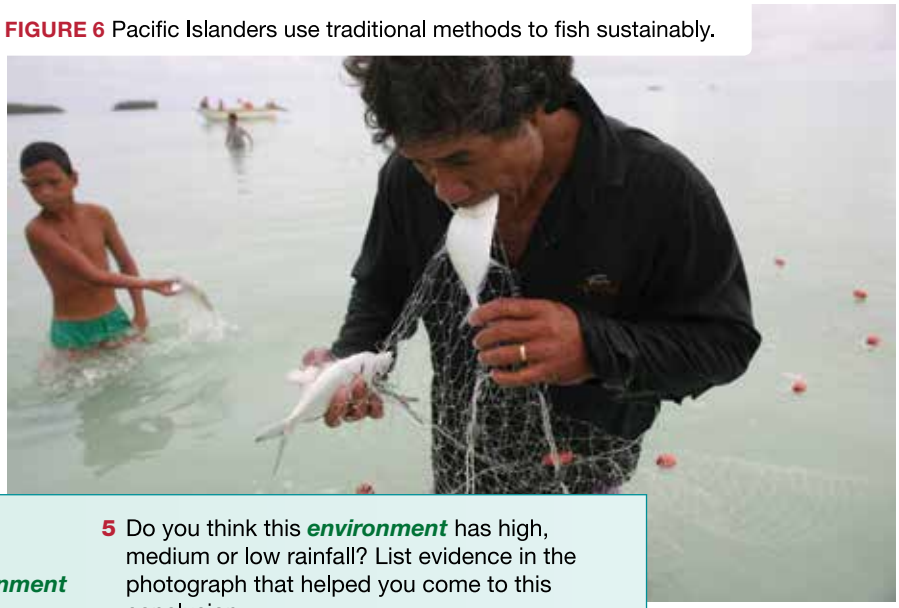
myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Change

1.2.6 What is environment?

People live in and depend on the environment, so it has an important influence on our lives.

The environment, defined as the physical and biological world around us, supports and enriches human and other life by providing raw materials and food, absorbing and recycling wastes, and being a source of enjoyment and inspiration to people.

FIGURE 6 Pacific Islanders use traditional methods to fish sustainably.



ACTIVITIES

Refer to figure 6.

1. Do you think the photograph of Pacific Islanders fishing depicts a natural ***environment*** or a human ***environment***? Explain.
2. Does this ***environment*** appeal to you? Would you like to visit this ***place***? Why? Why not?
3. Which resource/s do you think people would obtain from this ***environment***?
4. Describe how these people are fishing. Why might this be ***sustainable***?
5. Do you think this ***environment*** has high, medium or low rainfall? List evidence in the photograph that helped you come to this conclusion.
6. List the impacts on this ***environment*** if a factory was built on the edge of the water.
7. How have people changed this ***environment*** (for better or worse)? What are the positive and the negative aspects of this?
8. How might technology ***change*** this ***environment*** to make it less ***sustainable***?

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Environment

1.2.7 What is sustainability?

Sustainability is about maintaining the capacity of the environment to support our lives and those of other living creatures.

Sustainability involves maintaining and managing our resources and environments for future generations. It is important to understand the causes of unsustainable situations to be able to make informed decisions on the best way to manage our natural world.

FIGURE 7 The unsustainable nature of fishing



ACTIVITIES

Refer to figure 7.

1 What does this cartoon tell us about the ***sustainable*** nature of fishing?
2 How has modern technology contributed to a decline in world fish populations?
3 Suggest reasons that fishing can be considered an ***unsustainable*** practice.
4 Give reasons that some fish species are over-exploited while others are not.
5 What difficulties would arise with managing an ocean-based resource compared to a land-based resource?

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Sustainability

1.2.8 What is scale?

When we examine geographical questions at different spatial levels we are using the concept of scale to find more complete answers.

Scale can be applied at personal and local levels to regional, national or global levels. Looking at things at a range of scales allows a deeper understanding of geographical issues.

Different factors can be involved in explaining phenomena at different scales. Local events can have global outcomes; for example, removing areas of forest at a local scale can have an impact on climate at a global scale. A policy at a national scale, such as forest protection, can have an impact at a local scale, such as the protection of an endangered species.

ACTIVITIES

Refer to figures 8 and 9.

1 If you were to zoom in on the areas on these maps, would you see more or less detail?
2 List the extra information and detail you see on Annette's map compared to Jayden's map. Which gives more information?
3 Refer to the railway map. What might be the relationship between the location of settlements and the location of the railway?
4 The railway map is of a regional ***scale***. Which region of Australia is it showing?
5 Use the scale to measure the longest straight stretch of railway shown on the map. How long is it? Why is it significant?
6 What is the main information each map is trying to show?

FIGURE 8 Mental map of Jayden's local place (a) by Jayden and (b) by Annette, Jayden's mother

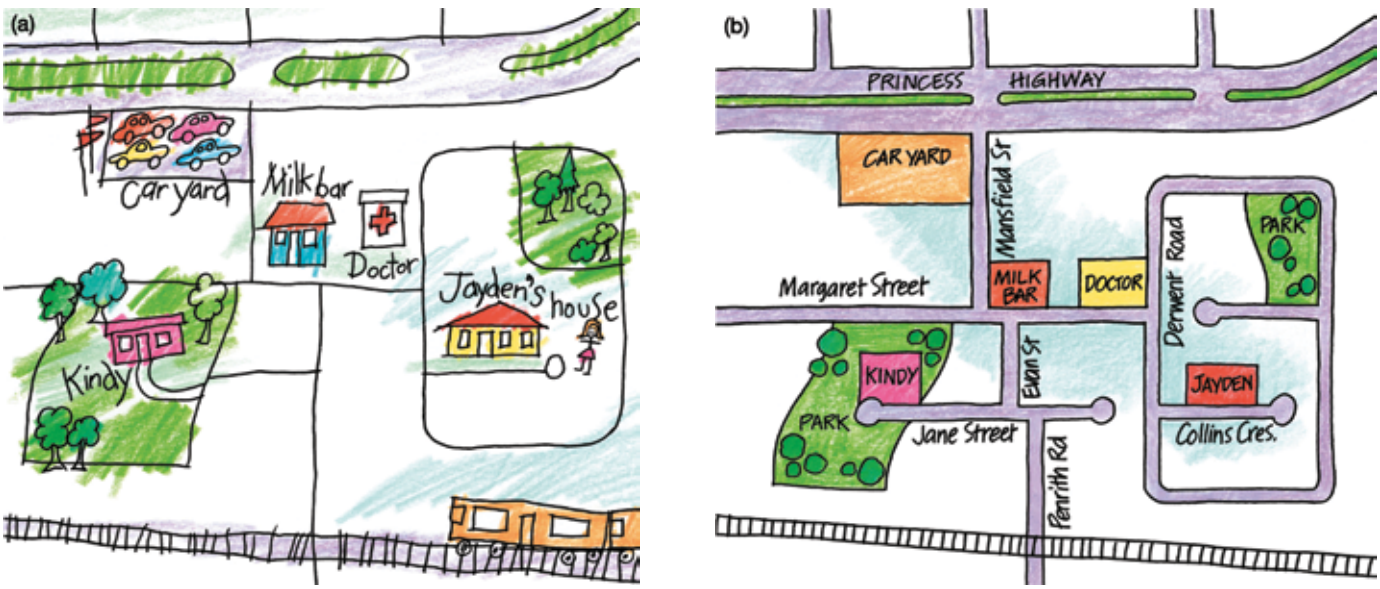


FIGURE 9 Railway route and main settlements between Sydney and Perth



Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Scale

1.3 Work and careers in Geography

1.3.1 Connecting Geography to school and work

As a student of Geography, you are starting to build the knowledge and skills that will be needed by you, your community; now and into the future. The concepts and skills that you will use will not only help you in Geography, but can also be applied to everyday situations such as finding your way from one place to another. Studying Geography may even help you in a future career here in Australia or overseas.

Throughout the year you will be studying topics that will give you a better understanding of the world around you – both the local and global environment. You will be investigating issues that need to be addressed, and investigate options for the future.

Explore: Skills you need for a job

Many questions come up during a typical Geography class, such as the ones below in table 1. These questions need to be answered in the real world by people in a wide variety of occupations that have links with Geography.

TABLE 1

Question	Occupations/organisations who try to answer these questions
• How high is Mount Everest? How do we know?	Surveyor; Cartographer
• How can we protect our parks and wildlife?	Park ranger; Planner; Environmental manager
• Where should we establish a new suburb for our future population?	Urban planner; Demographer
• How can we prepare for future droughts and floods?	Civil engineer
• Does our town really have enough water? • Where should we build a new dam? *Should* we build a new dam?	Coastal engineer; Hydrologist; Cartographer

(*Continued*)

TABLE 1 (*Continued*)

Question	Occupations/organisations who try to answer these questions
• Should a boat marina be built at location X or at location Y?	Oceanographer
• Do we have good quality drinking water?	Chemist; Hydrologist
• How do countries such as India and China deal with air pollution problems?	Environmental scientist/manager
• How do we provide aid to other countries?	Air Force, Navy, Army officer; Red Cross, World Vision and other aid agencies
• How do we build sustainable housing?	Architect; Landscape architect; Civil engineer/ Construction manager; Town planner; Real estate salespeople

Think: Consider who you are and what your position in the world is …

Do you know much about these occupations? Are any of interest to you?

The first step in thinking about your future is to consider questions such as:

- Who am I?
- What are my interests?
- What do I enjoy doing?
- What am I good at?
- What would I like to do when I leave school?

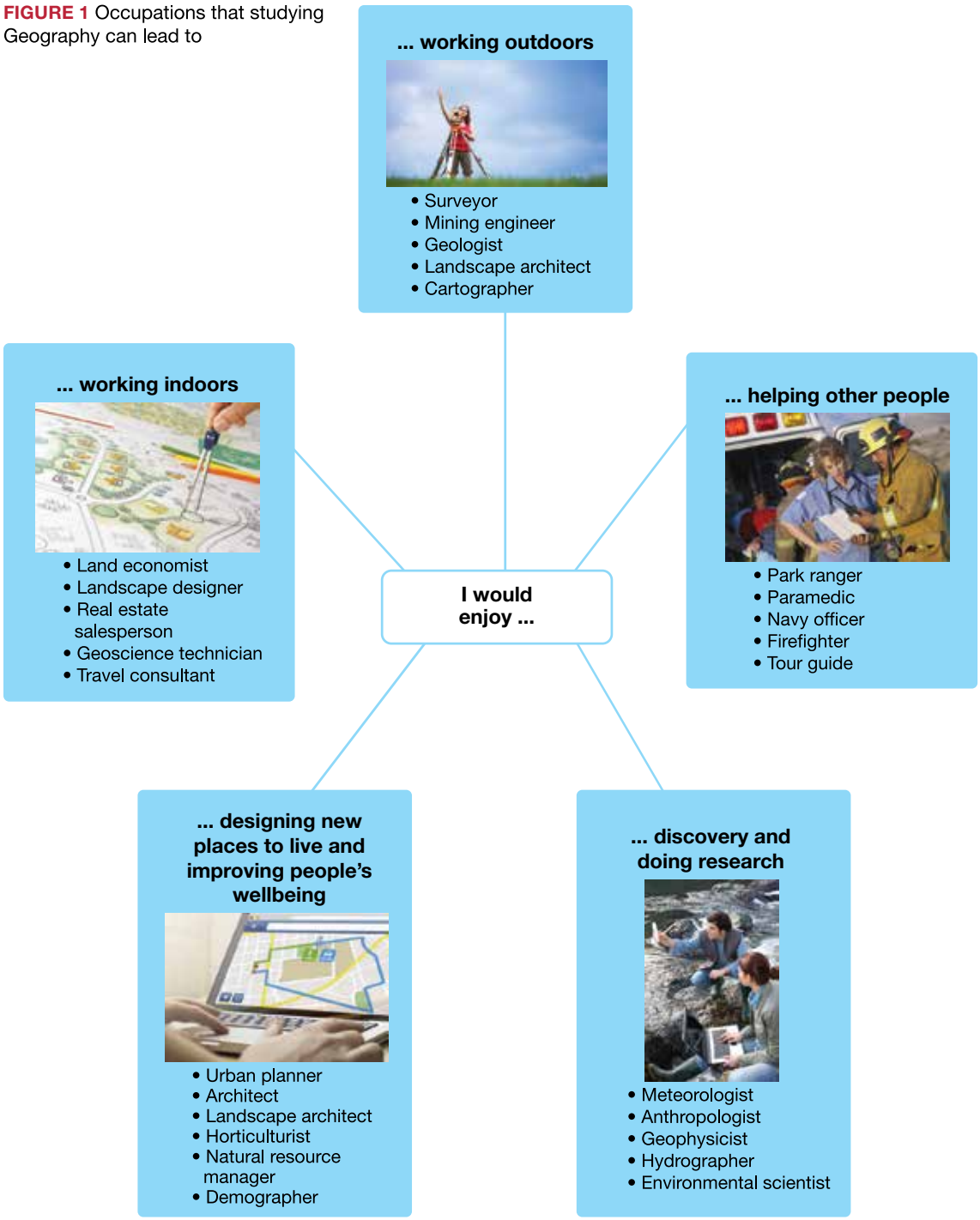




1.3.2 Geography careers on the move

A great part of studying Geography is being able to explore the many occupations and areas that it opens up. Figure 1 shows some occupations that you may not have thought studying Geography could lead you into.

FIGURE 1 Occupations that studying Geography can lead to



1.3.3 Finding my way as a local and global citizen

A wide range of exciting new jobs are developing in the spatial sciences, which use geographical tools such as GPS, GIS, satellite imaging and surveying. These tools help people make important decisions about managing and planning places and resources. Whether it be how to manage water somewhere in the Middle East or how best to design a new housing estate here in Australia, these skills and occupations will be an important part of working as a global citizen.

eBookplus

Weblink
Geocareers

ACTIVITIES

PREDICT

1 Consider spatial technologies and work and enterprise careers of the future. Which geographical tools do you predict will be used by:
- a meteorologist
- a naval officer
- an airline pilot
- a farmer?

DISCOVER

2 We can develop a better understanding of work and enterprise by exploring what others have to say about their careers. Use the **Geocareers** weblink in your eBookPLUS to help you locate one male and one female geographer working as local or global citizens.
- What career path did they follow?
- How did they include their passion for geography into their career journey?
- What advice did they share about their career journey?

1.4 Review

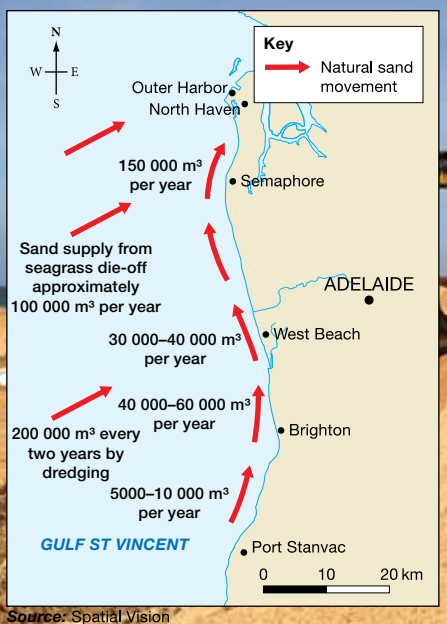
1.4.1 Applying the concepts

For the past 7000 years, the sandy beaches close to Adelaide in South Australia have been eroding and the sand has been moved northwards by the prevailing winds from the south-west. This has resulted in the growth of a peninsula and large dune system at North Haven.

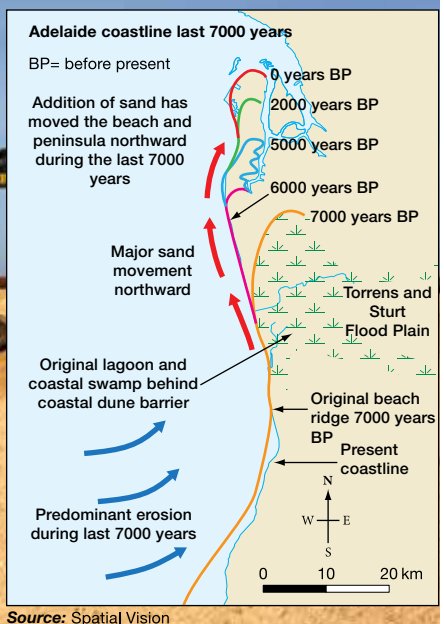
As many people have now settled along this coastline, the sand movement is being managed to stop erosion by trapping the sand or trucking and piping it back to the south. The cost of this action can be very high.

FIGURE 1 Sand is being transported from north to south along Adelaide's beaches

FIGURE 2 The movement of sand northwards along the Adelaide Metropolitan coastline



Source: Spatial Vision

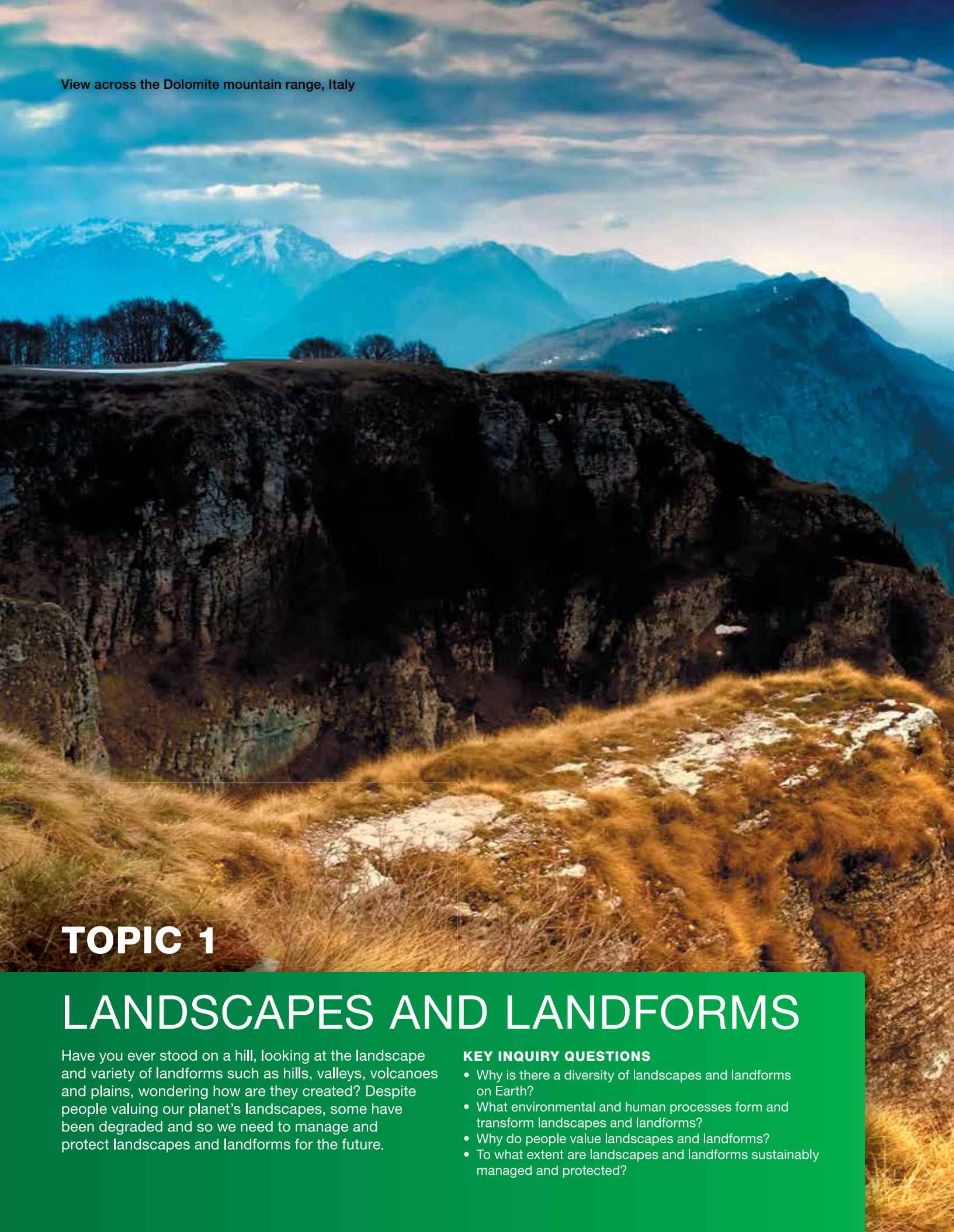


Source: Spatial Vision

ACTIVITIES

Note: The terms in brackets are intended to help students identify which concept the question is related to.

1. Use an atlas to describe the location of Adelaide relative to where you live. What is its absolute location? (***space***)
2. Is the Adelaide coast a ***place*** where you would like to live? Why or why not?
3. How would the perception of coastal erosion differ between people who live in coastal settlements and those living five or more kilometres inland? (***place***)
4. What are the human natural characteristics of this ***place***? Do you think this coastal ***environment*** is natural or human? Justify your answer.
5. What is the length of the coastline shown on the map? (***scale***)
6. Describe how this ***environment*** may have looked 7000 years ago. How has it ***changed*** over time?
7. How have people ***changed*** this ***environment***?
8. What is the relationship (***interconnection***) between:
   a. prevailing wind and sand movement (the prevailing wind along this coastline comes from the south-west)
   b. sand movement and formation of coastal features?
9. Which local management ***scale*** is shown in the photograph?
10. How has technology helped manage this coastline? (***change***)
11. What ***changes*** might occur if the sand movement was not managed?
12. Is the movement of sand to stop beach erosion a ***sustainable*** activity — that is, is it worth stopping the movement of sand? Explain your answer.



View across the Dolomite mountain range, Italy

TOPIC 1

LANDSCAPES AND LANDFORMS

Have you ever stood on a hill, looking at the landscape and variety of landforms such as hills, valleys, volcanoes and plains, wondering how are they created? Despite people valuing our planet's landscapes, some have been degraded and so we need to manage and protect landscapes and landforms for the future.

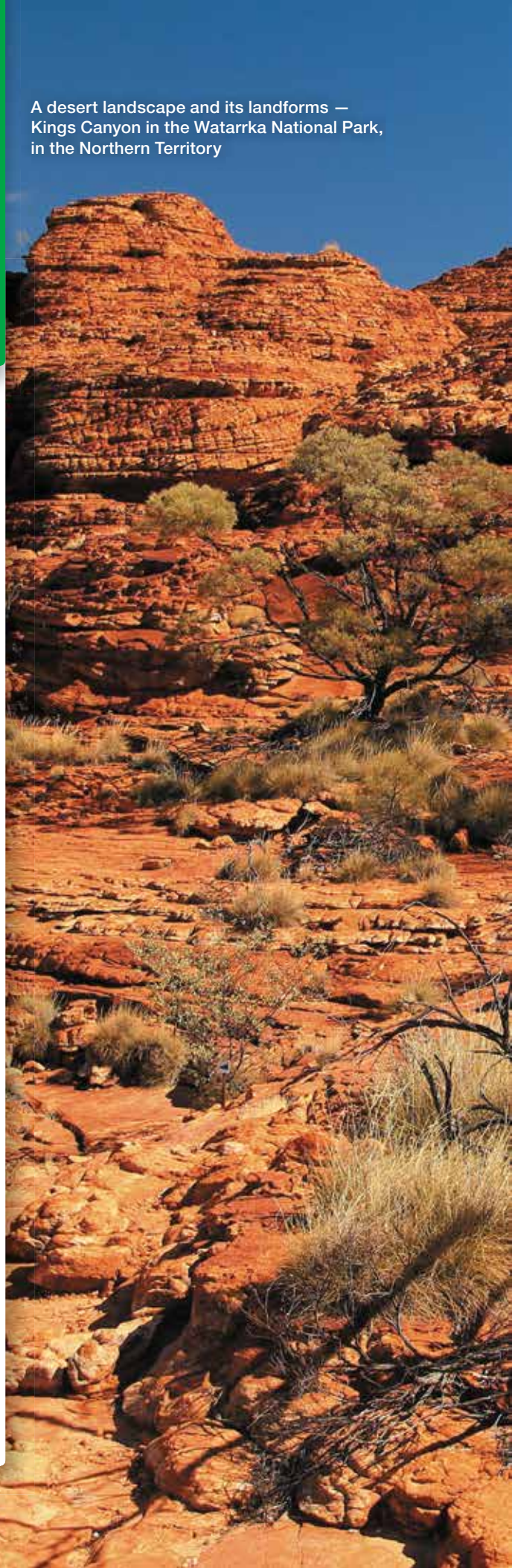
KEY INQUIRY QUESTIONS

- Why is there a diversity of landscapes and landforms on Earth?
- What environmental and human processes form and transform landscapes and landforms?
- Why do people value landscapes and landforms?
- To what extent are landscapes and landforms sustainably managed and protected?



CHAPTER 2

The diversity and formation of landscapes and landforms



A desert landscape and its landforms — Kings Canyon in the Watarrka National Park, in the Northern Territory

2.1 Overview

2.1.1 Introduction

Landscapes are the visible features occurring across an area of land. They are created by a combination of environmental processes and human activities. Examples include coastal, desert and agricultural landscapes.

Landforms are distinctive, natural features occurring on the surface of the Earth. They are identifiable by their shape. Examples of landforms include: plateaus, canyons, valleys, hills and dunes.

Landscapes often include a variety of landforms.

Starter questions

1. Identify key features of the landscape shown in the image at right.
2. Watch the video and identify the landforms shown.
3. Identify and locate different landscapes around the world. Describe your favourite landscape and provide a reason why it is your favourite.
4. Brainstorm as a class different landscapes around the world. Describe your favourite landscape and explain why it appeals to you.

Inquiry sequence

		Syllabus outcomes
2.1 Overview		
2.2 What are different types of landscapes?		GE4-1, GE4-2
2.3 What types of landscapes and landforms are there in Australia?		GE4-1, GE4-2
2.4 SkillBuilder: Recognising land features	eBookplus ONLINE ONLY	GE4-7, GE4-8
2.5 What types of landscapes are found in the Pacific region?	eBookplus ONLINE ONLY	GE4-1, GE4-2
2.6 What processes transform landscapes?		GE4-2, GE4-8
2.7 Which landscapes are created by water?		GE4-2, GE4-8
2.8 How are landscapes created underground?		GE4-2, GE4-8
2.9 How are river landscapes created?	eBookplus ONLINE ONLY	GE4-2, GE4-8
2.10 How are coastal landscapes shaped by erosion?	eBookplus ONLINE ONLY	GE4-2, GE4-8
2.11 How are coastal landscapes shaped by deposition?	eBookplus ONLINE ONLY	GE4-2, GE4-8
2.12 How do I undertake coastal fieldwork?		GE4-1, GE4-2, GE4-7, GE4-8
2.13 SkillBuilder: Constructing a field sketch	eBookplus ONLINE ONLY	GE4-7, GE4-8
2.14 SkillBuilder: How to read a map	eBookplus ONLINE ONLY	GE4-7, GE4-8
2.15 Investigating topographic maps: What are topographic maps?		GE4-1, GE4-7, GE4-8
2.16 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
World landscapes and landforms
Searchlight ID: eles-1623

2.2 What are different types of landscapes?

plateau an extensive area of flat land that is higher than the land around it. Plateaus are sometimes referred to as tablelands.

2.2.1 Global landscapes

There are many different landscapes across the Earth, and similarities can be observed within regions. Variations in landscapes are influenced by factors such as climate; geographical features, including mountains and rivers; latitude; the impact of humans; and where the landscapes are located.

FIGURE 1 Selected world landscapes

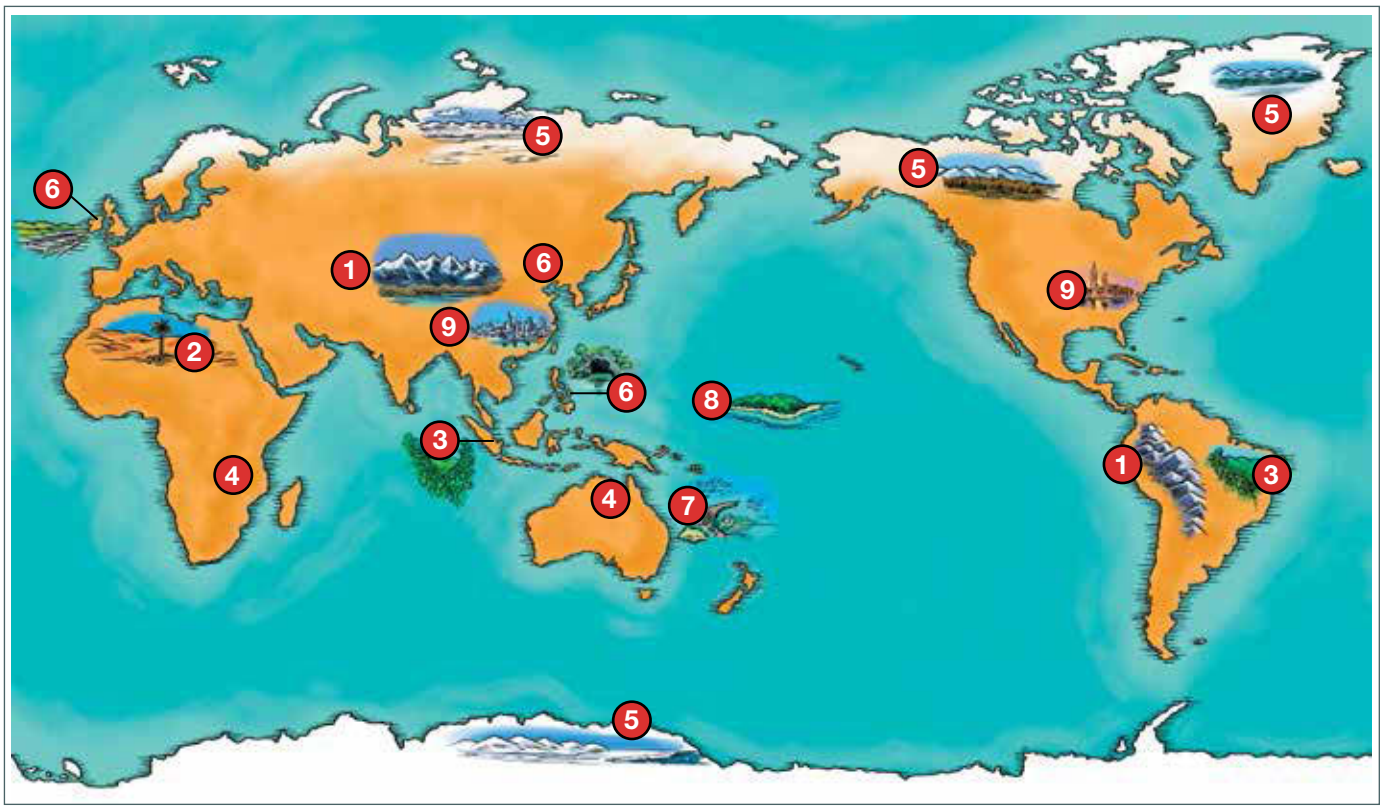


FIGURE 2 At 8848 metres, Mount Everest in the Himalayas is the highest mountain on Earth.



2.2.2 Mountain landscapes 1

Mountains rise above the surrounding land. They often have steep sides and high peaks and are the result of processes operating deep inside the Earth. Some reach high into the atmosphere where it is so cold that snow is found on their peaks.

2.2.3 Desert landscapes 2

Deserts are areas of low rainfall; they are an arid or dry environment. They can experience temperature extremes: hot by day and freezing at night. However, not all deserts are hot. Antarctica is the world's largest desert, and the Gobi Desert, located on a high **plateau** in Asia, is also a cold desert.

2.2.4 Rainforest landscapes 3

Rainforests are the most diverse landscapes on Earth. They are found in a variety of climates, ranging from the hot wet tropics to the cooler temperate areas.

The lush vegetation found in these regions depends on a high level of rainfall. Over 50 per cent of all known plant and animal species are found within them. In addition, many of our foods and medicines come from rainforests.

2.2.5 Grassland landscapes 4

Grasslands, or savanna, are sometimes seen as a transitional landscape found between forests and deserts. They contain grasses of varying heights and coarseness, and small or widely spaced trees. They are often inhabited by grazing animals.

2.2.6 Polar landscapes 5

Polar regions and tundra can be found in polar and alpine regions. Characterised by **permafrost**, they are too cold for trees to grow. Vegetation such as dwarf shrubs, grasses and lichens have adapted to the extreme cold and short growing season. **Glaciers** often carve spectacular landscape features.

2.2.7 Karst landscapes 6

Karst landscapes form when mildly acidic water flows over soluble rock such as limestone. Small fractures form, which increase in size over time and lead to underground drainage systems developing. Common landforms include limestone pavements, disappearing rivers, reappearing springs, sinkholes, caves and karst mountains. Around 25 per cent of the world's population obtains water from karst **aquifers**.

permafrost a layer beneath the surface of the soil where the ground is permanently frozen

glacier a large body of ice, formed by an accumulation of snow, which flows downhill under the pressure of its own weight

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater

FIGURE 3 These karst caves in the United States are protected.



2.2.8 Aquatic landscapes 7

Aquatic landscapes cover around three-quarters of the Earth and can be classified as freshwater or marine. Marine landscapes are the saltwater regions of the world, and include oceans and coral reefs. Freshwater landscapes are found on land, and include lakes, rivers and wetlands.

2.2.9 Island landscapes 8

Islands are areas of land that are completely surrounded by water. They can be continental or oceanic. Continental islands lie on a continental shelf — an extension of a continent that is submerged beneath the sea. Oceanic islands rise from the ocean floor and are generally volcanic in origin. A group or chain of islands is known as an archipelago.

2.2.10 Built landscapes 9

Human or built landscapes are those that have been altered or created by humans.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Grasslands

ACTIVITIES

IDENTIFY

1 List the factors that make landscapes different.

EXPLAIN

2 Why do you think people ***change*** landscapes?

3 The map in figure 1 shows the wide variety of landscapes found on the surface of the Earth. However, it does not show all locations for each landscape type. Investigate one of the featured landscapes and find out other ***places*** in which it is found. Show this information on a map. Annotate your map with characteristics of your landscape.

INVESTIGATE

4 Copy the following table into your workbook.

a Select one of the landscape types described in this section and complete the table.

Landscape characteristics	How people use it	Positive effects	Negative effects

b Which list is larger — the positive impacts or negative impacts?

c Review the column of negative impacts. Select three of these impacts and suggest a way in which the ***environment*** could be used in a more ***sustainable*** way.

5 Describe how the ***scale*** of the following landscapes might differ around the world: deserts, polar regions, aquatic landscapes and islands.

eBook*plus*

Interactivity
Landscapes galore
Use this interactivity to learn about the variety of landscapes that are around us.
Searchlight ID: int-3102

2.3 What types of landscapes and landforms are there in Australia?

2.3.1 What processes have shaped Australia's landscapes and landforms?

The tectonic forces of folding, faulting and volcanic activity have created many of Australia's major landforms. Other forces that work on the surface of Australia, and give our landforms their present appearance, are **weathering**, mass movement, **erosion** and **deposition**. These forces are examples of geomorphic processes.

Australia is an ancient landmass. The Earth is about 4600 million years old, and parts of the Australian continent are about 4300 million years old.

weathering the breaking down of rock through the action of wind and water and the effects of climate, mainly by water freezing and cooling as a result of temperature change

erosion the wearing away and removal of soil and rock by natural elements, such as wind, waves, rivers or ice, and by human activity

deposition the laying down of material carried by rivers, wind, ice and ocean currents or waves

FIGURE 1 Many of Queensland's mountain peaks were formed by volcanic activity around 20 million years ago. The Glasshouse Mountains, north of Brisbane, are volcanic plugs. They are composed of volcanic rock that hardened in the vent of a volcano. Over millions of years, weathering and erosion have worn away the softer rock that surrounded the vent, leaving only the plugs.



Over millions of years, Australia has undergone many changes. Mountain ranges and seas have come and gone. As mountain ranges eroded, sediments many kilometres thick were laid down over vast areas. These sedimentary rocks were then subjected to folding, faulting and uplifting. This means that the rocks that make up the Earth's crust have buckled and folded along areas of weakness, known as faults. Sometimes, fractures or breaks occur, and forces deep within the Earth cause sections to be raised, or uplifted. Over time the forces of weathering and erosion have worn these down again. Erosion acts more quickly on softer rocks, forming valleys and bays. Harder rocks remain as mountains, hills and coastal headlands.

Because it is located in the centre of a **tectonic plate**, rather than at the edge of one, Australia currently has no active volcanoes on its mainland, and has very little tectonic lift from below. This means its raised landforms such as mountains have been exposed to weathering forces for longer than mountains on other continents and are therefore more worn down.

About 33 million years ago, when Australia was drifting northwards after splitting from Antarctica, the continent passed over a large **hotspot**. Over the next 27 million years, about 30 volcanoes erupted while they were over the hotspot. The oldest eruption was 35 million years ago at Cape Hillsborough, in Queensland, and the most recent was at Macedon in Victoria around six million years ago. Over millions of years, these eruptions formed a chain of volcanoes in eastern and south-eastern Australia, that are known today as the Great Dividing Range. At present, the hotspot that caused the earlier eruptions is probably beneath Bass Strait (see figure 2).

FIGURE 2 Relief map of Australia's east coast. The Great Dividing Range stretches from north of Cairns in Queensland to Mount Dandenong near Melbourne in the south.



Source: Spatial Vision

tectonic plate one of the slow-moving plates that make up the Earth's crust. Volcanoes and earthquakes often occur at the edges of plates.

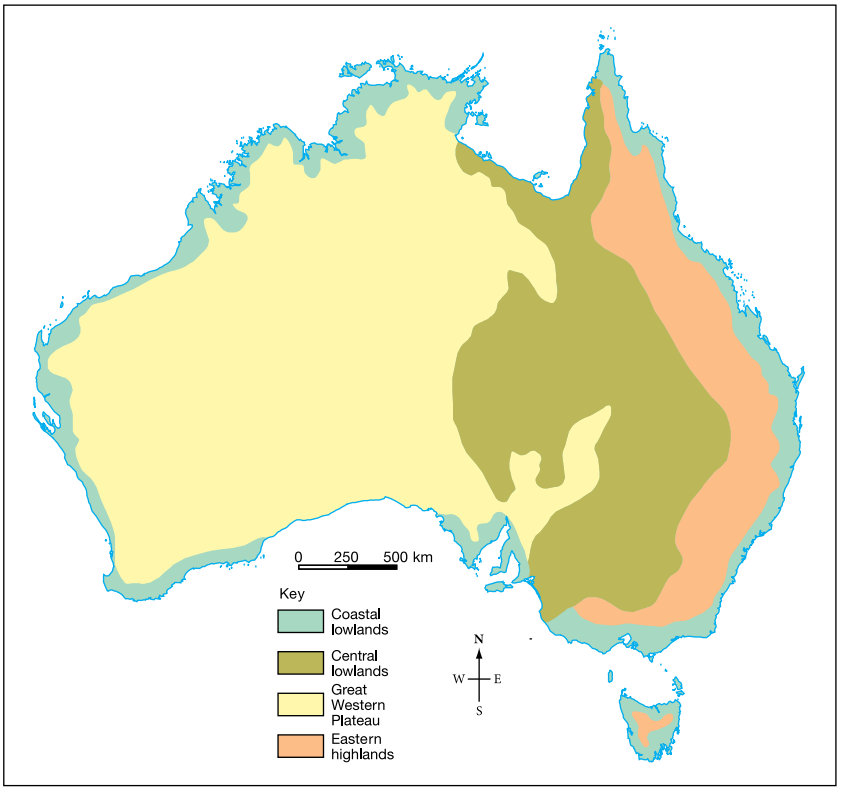
hotspot an area on the Earth's surface where the crust is quite thin, and volcanic activity can sometimes occur, even though it is not at a plate margin

The present topography of much of Australia results from erosion caused by ice. For example, about 290 million years ago a huge icecap covered parts of Australia. After the ice melted, parts of the continent subsided and were covered by sediment, forming sedimentary basins (a low area where sediments accumulate) such as the Great Artesian Basin. On a smaller scale, parts of the Australian Alps and Tasmania have also been eroded by glaciers during the last ice age.

Rivers and streams are another cause of erosion, having carved many of the valleys in Australia's higher regions.

When streams, glaciers and winds slow down, they deposit or drop the material they have been carrying. This is called deposition. Many broad coastal and low-lying inland valleys have been created by stream deposition. These areas are called floodplains.

FIGURE 3 Australia's four major landform regions



Source: MAPgraphics Pty Ltd Brisbane

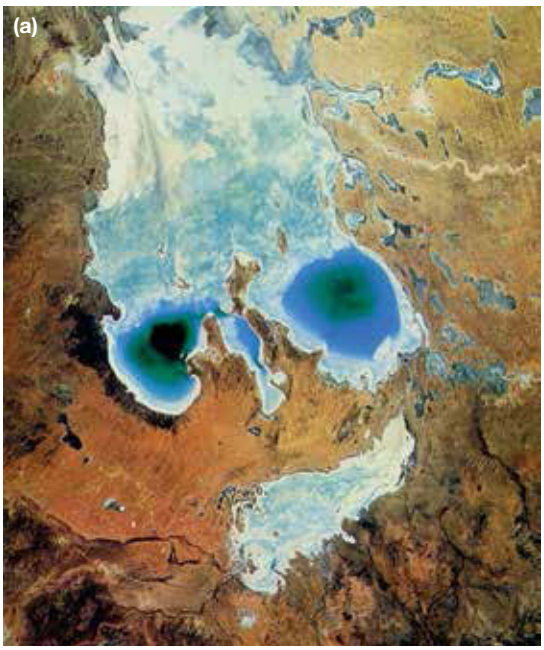
What are Australia's landform regions?

The topography of Australia can be divided into four major regions (see figure 3).

- The coastal lowlands around Australia's edge are narrow and fragmented. The plains often take the form of river valleys, such as the Hunter River Valley near Newcastle.
- The eastern highlands region (which includes the Great Dividing Range) is mainly a series of tablelands and plateaus. Most of the area is very rugged, because rivers have cut deep valleys. It is the source of most of Australia's largest rivers, including the Fitzroy, Darling and Murray. The highest part is in the south-east, where a small alpine area is snow-covered for more than half the year.
- The central lowlands are a vast area of very flat, low-lying land that contains three large **drainage basins**: the Carpentaria Lowlands in the north, the Lake Eyre Basin in the centre (see figure 4) and the Murray–Darling Basin in the south.
- The Great Western Plateau is a huge area of tablelands, most of which are about 500 metres above sea level. It includes areas of gibber (or stony) desert and sandy desert. There are several rugged upland areas, including the Kimberley and the McDonnell Ranges.

drainage basin the entire area of land that contributes water to a river and its tributaries

FIGURE 4 Lake Eyre, the lowest point on the Australian mainland, is part of the Great Artesian Basin. It is 15 metres below sea level. Once a freshwater lake, the region is now the world's largest salt pan. The evaporated salt crust shows white in the satellite image (a) below left. The lake fills with water only three or four times each century, transforming it into a haven for wildlife. Deep water is shown as black in image (b) below right.





myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Uluru

CASE STUDY

The Murray–Darling Basin

The Murray–Darling River covers about one million square kilometres, and more than 20 major rivers flow into it. It has a wide variety of landscapes, ranging from alpine areas in the south-east to plains in the west. The basin produces 43 per cent of Australia's food and over 40 per cent of Australia's total agricultural income.

The Murray–Darling Basin is the largest and most important drainage basin in Australia, covering one-seventh of the continent. However, the amount of water flowing through it in one year is about the same as the *daily* flow of the Amazon River. The basin is facing severe problems.

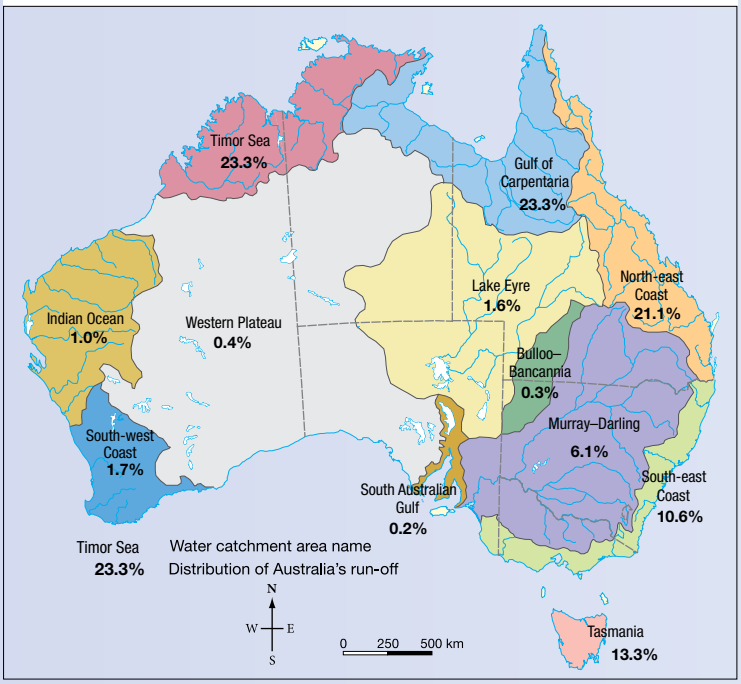
- Only about 20 per cent of the water flowing through the basin ever reaches the sea. The rest is diverted for agriculture, industry and domestic use.

FIGURE 5 Aerial view of the Murray River, where it enters the Coorong and Lake Alexandrina in South Australia



- The Murray supplies about 40 per cent of Adelaide's drinking water. The quality of the water continues to decline, mainly because of salinity levels.
- Approximately 50 to 80 per cent of the wetlands in the basin have been severely damaged or destroyed, and more than a third of the native fish species are threatened with extinction.
- In 2008, inflows into the river system were at their lowest levels since records began 117 years earlier.
- An estimate of weather trends shows that the flow to the Murray River mouth may be reduced by a further 25 per cent by 2030. However, with the added problem of climate change, it is predicted that precipitation in the Murray–Darling catchment will decrease, so that the reduction in flow to the mouth could be as high as 70 per cent.

FIGURE 6 Australia's drainage basins



Source: MAPgraphics Pty Ltd Brisbane

FIGURE 7 Lake Eyre and surrounding drainage systems



Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Murray–Darling Basin

How does water flow across the land?

Permanent rivers and streams flow in only a small proportion of the Australian continent. Australia is in fact the driest of all the world's inhabited continents. It has:

- the least amount of run-off
- the lowest percentage of rainfall as run-off
- the least amount of water in rivers
- the smallest area of permanent wetlands
- the most variable rainfall and stream flow.

Australia has many lakes, but they hold little water compared with those found on other continents. The largest lakes are Lake Eyre (see figure 4) and Lake Torrens in South Australia. During the dry seasons, these become beds of salt and mud. Yet an inland sea did once exist in this area. It covered about 100 000 square kilometres around present-day Lake Eyre and Lake Frome. South Australia is Australia's driest state, and has very few permanent rivers and streams.

GEOskills TOOLBOX

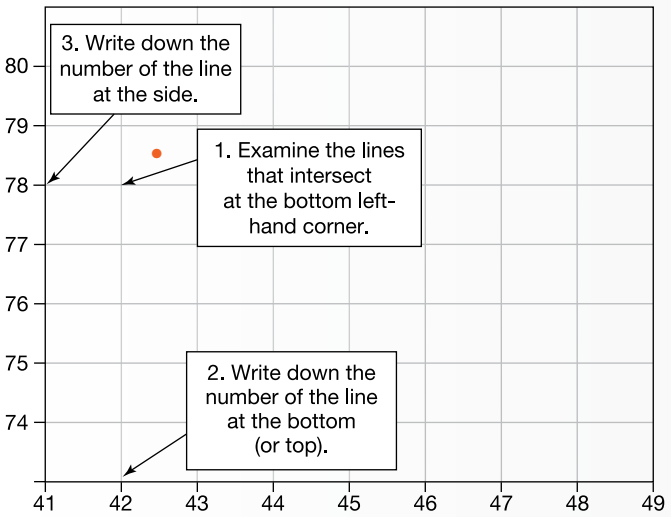
Area and grid references

Topographic maps usually have grids with numerical references. The lines that are horizontal are called northings. The lines that are vertical are called eastings.

- Area references have 4 digits, for example AR4278.
- Grid references have 6 digits, for example GR425786.

To work out area references, go to the bottom left-hand corner of the square. Examine the lines which are intersecting. Write down the number of the line at the bottom (or top) first and then write down the number of the line at the side.

FIGURE 8 Steps to determine the area reference of a location



To work out a grid reference you need to imagine that the square has been divided into tenths along both the northing and the easting.

- The area reference of this square is AR4276.
- The grid reference of this point is GR424766.

1 Determine the area references for points 1–10.
2 Determine the grid references for points 1–10.

FIGURE 9 Steps to determine the grid reference of a location

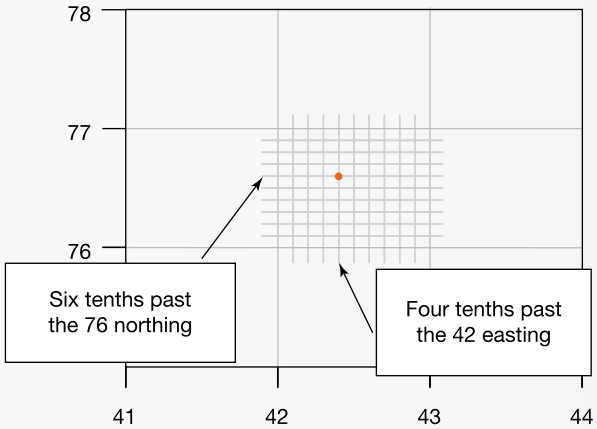
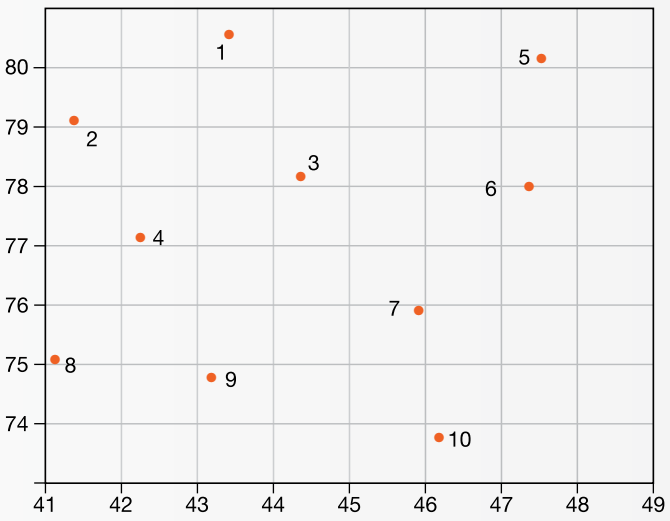


FIGURE 10 A basic grid is an important feature of a topographic map.



ACTIVITIES

IDENTIFY

1 In your own words, explain what is meant by the terms *folding*, *faulting* and *uplift*.
2 Describe some of the physical ***changes*** Australia's landmass has undergone.
3 Describe the major characteristics of Australia's four main landform regions.

EXPLAIN

4 Explain why Australia is so low in altitude compared with other continents.

INVESTIGATE

5 Use an atlas to complete the table below, listing the highest mountains in each Australian state and territory. Describe the location of each.

State/ Territory	Highest mountain	Elevation (metres)	Absolute location	Relative location
New South Wales				
Victoria				
Queensland				
Tasmania				
Western Australia				
South Australia				
Northern Territory				
Australian Capital Territory				

6 Use Google Earth to view any part of the Murray–Darling Basin. Describe the landscape.
7 Divide your class into four groups. Assign each group one of Australia's landform regions to investigate. Collectively compile a list of landforms that are found in each region. Then have each member of the group investigate a different landform and prepare a series of PowerPoint slides that show the following:
   a the landform
   b where it is located
   c how it was formed
   d whether people might want to visit this landform, including the reasons why it is or is not a popular landform.

   Put the individual presentations together for viewing by the rest of the class.
   Refer to the information on page 28 to complete this question.
8 Use your atlas to find the Cape Hillsborough and Macedon volcanoes, or refer to figure 2.
   a Calculate the distance between them.
   b Use the information in this section to work out the rate at which the Australian landmass is moving.
   c How far has Australia moved over the Bass Strait hotspot? Now calculate where under Bass Strait this hotspot might now lie.
   d Use the information in this section to explain why this hotspot has ***changed*** its location over time.
9 It is said that the amount of water that flows down the Amazon River in a day is more than flows down the Murray in a year.
   a What does that tell you about how dry Australia's climate is?
   b How might this affect the way the ***environment*** around the Murray River is affected?

APPLY

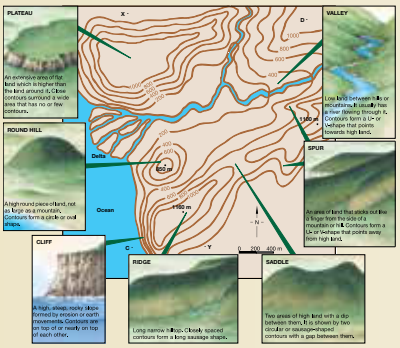
10 Australia is an ancient landmass and has undergone many ***changes*** over millions of years. In groups, brainstorm and compile lists under the following headings.
   - Physical ***changes*** that have taken place on the Australian landmass
   - Tectonic processes that have contributed to these ***changes***
   - ***Changes*** caused by processes such as weathering and erosion
   - Within your group, write a series of paragraphs that explain the ***interconnection*** between these factors.

eBookplus ONLINE ONLY

2.4 SkillBuilder: Recognising land features

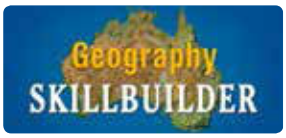
What are land features?

Land features are landforms with distinct shapes, such as hills, valleys and mountains. You can recognise these as you look around your natural environment. On topographic maps you can recognise land features from the patterns formed by the contour lines.



eLesson

Watch this video to learn how to recognise land features.



Searchlight ID: eles-1648

Interactivity

Try this interactivity to learn how to recognise land features.



Searchlight ID: int-3144

eBookplus ONLINE ONLY

2.5 What types of landscapes are found in the Pacific region?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

2.6 What processes transform landscapes?

2.6.1 Are all processes natural?

There are processes at work that continuously sculpt and change the landscape. In the future, the Earth's surface will look very different from the way it looks today.

There are a variety of natural processes that shape and reshape not only the surface of the Earth, but also what lies beneath it. Natural processes, also called geomorphological processes, include uplift, such as that caused by tectonic activity, erosion, deposition and weathering. People change the landscape when they clear land for agriculture or build cities and road networks; these are known as human processes. Sometimes they alter the course of a river or trap its flow behind the walls of a dam.

What role do tectonic forces play?

The Earth's surface, or crust, is split into a number of plates, which fit together like a giant jigsaw puzzle. These plates sit on a layer of semi-molten material in the Earth's **mantle** — the layer of the Earth between the crust and the core. Heat from the Earth's core creates convection currents within the mantle, causing the plates to move. Most of the Earth's great mountain regions were formed as a result of this movement.

mantle the layer of the Earth between the crust and the core

FIGURE 1 Over millions of years, the Colorado River has cut deep channels to form the Grand Canyon.



When two plates collide, one plate often slides under the other, in a process known as subduction, and it becomes part of the mantle. Other rocks are forced upwards and bent or folded. Large mountain ranges that were formed in this way include the Himalayas in Asia and the Rocky Mountains in North America.

transportation the movement of eroded materials to a new location by elements such as wind and water

How is the landscape worn away?

Erosion is the wearing away of the Earth's surface by natural elements such as wind, water, ice and human activity. The landscape is further eroded when agents such as wind, water and ice **transport** these materials to new locations. Eventually, transported material is deposited in a new location. Over time, this material can build up and new landforms result. The Grand Canyon in Colorado in the United States (figure 1) is an example of these elements at work. These processes work more quickly on softer rocks.

Human activity also contributes to erosion. Deforestation, agriculture, urban sprawl, logging and road construction all alter the natural balance and increase erosion by as much as 40 per cent in some areas. Vegetation not only provides valuable habitat for native animals but also is vital for binding the soil together. Once vegetation is removed, it is more easily broken down and removed by wind and water. When topsoil is removed, plants are unable to obtain the nutrients they need for growth. Sometimes wide, deep channels, known as gullies, form (figure 2).

FIGURE 2 Deep gullies caused by human activity



FIGURE 3 After tectonic forces cause a section of the Earth to be raised (uplifted), other processes take over and re-sculpt the landscape.

1 Weathering is the breakdown of rocks due to the action of rainwater, temperature change and biological action. The material is not transported (removed).

It can be physical, chemical or biological.

2 Erosion is the process whereby soil and rocks are worn away and moved to a new location by agents such as wind, water or ice.

3 Transportation is the process that moves eroded material to a new location — examples include soil carried by the wind, and sediment or pebbles in a stream.

4 Deposition — materials moved by wind and water eventually come to a halt. Over time new landforms are built. Sand dunes and beaches are common landforms associated with deposition.

Physical — occurs where water is continually freezing and thawing. The water penetrates cracks and holes in the rocks. As water freezes it expands, making the cracks larger. Over time the rock breaks apart.

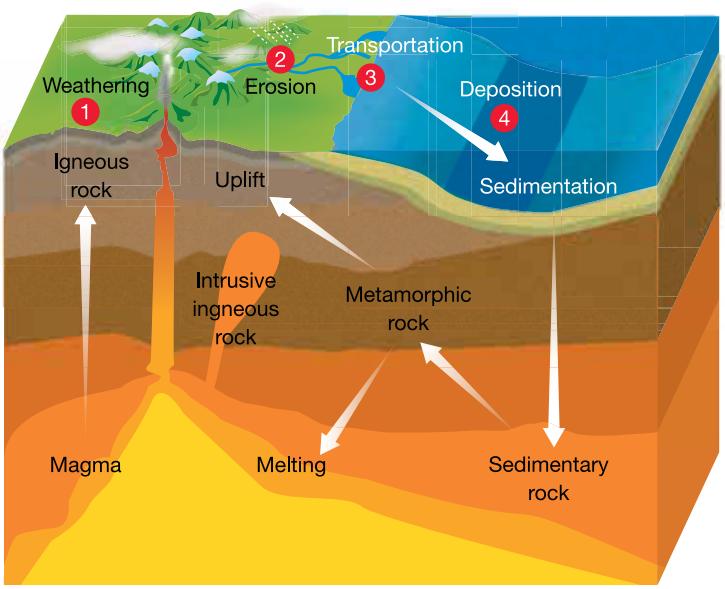


Chemical — some rocks, such as limestone, contain chemicals that react with water causing the limestone to dissolve.



Biological — living organisms such as algae produce chemicals that break down rocks. They can also be forced apart by plant roots.





ACTIVITIES

IDENTIFY

1 In your own words, define the natural processes at work shaping the Earth.

EXPLAIN

2 Explain how and why human activity might contribute to weathering and erosion.

3 Using terms such as *uplift*, *erosion*, *deposition*, *weathering* and *transportation*, explain the ***interconnection*** between landscapes and physical processes.

4 Choose a landscape to investigate using the internet.

- **a** Copy and paste an image of this landform into a Word document
- **b** Annotate the image with information about its location, formation and change over time.
- **c** Develop a sketch to show how this landform might have looked in the past and how it might look in the future.
- **d** Ensure that you show the source of the image.

PREDICT

5 Study the ***environment*** around your home or school and find a ***place*** where there is evidence of erosion. Make a sketch and label the features of the landscape. Highlight areas where erosion is evident and add annotations to explain what you think might have caused this ***change***, and in particular, the ***scale*** of this ***change***. Estimate the proportion of this ***environment*** that has been affected. What proportion do you think is the result of human activity? Compare your estimate with the figure given in this section.

eBook*plus*

Interactivity
Break down!
Use this interactivity to learn how weathering, erosion and deposition shape our landscapes.
Searchlight ID: int-3101

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **› Active Earth**

2.7 Which landscapes are created by water?

2.7.1 How does water change landscape features?

A torrent of gushing water can shift rocks, remove topsoil or shape river valleys. Gentle rain can change the chemical structure of any surface material, making it more likely that soil will be transported by the next heavy shower. In cold climates, frozen water in glaciers works like a slow-moving bulldozer to erode land and create unique landscape features. Once fresh water has made its way to the ocean, the power of waves creates coastal landscape features.

Landscapes are predominantly changed or created by two processes: erosion and deposition (see sections 2.10 and 2.11). Water is one of the most powerful agents, causing erosion and deposition, and thereby breaking up, moving and repositioning material across the Earth's surface. In figure 2 you can see the power of water as it rushes over a rockface and carves pools in its hard surface. You may have seen pools of a similar shape carved by waves in rocky coastal landforms.

FIGURE 1 The Twelve Apostles in Port Campbell National Park, Victoria. How might the potential for erosion change along this coast if the waves were larger and it was high tide?



As water makes contact with landscapes, it can change the shape and size of its features or landforms (figures 2 and 3). The coastal landscape that you see today is not the same as it was hundreds or thousands of years ago. Figure 1 is a photo of the Twelve Apostles, located on the coast of south-western Victoria. The name suggests that there may once have been twelve pillars of rock, or stacks, visible along this stretch of coastline. In the foreground you can see the remnants of two quite recently collapsed stacks. Even these stacks were once joined to the cliffs as part of the mainland. This highly erodible coastline has been constantly altered by many years of rainfall and wave action on the soft limestone cliffs. The resulting coastline has seen much creation and destruction of stacks over time.

FIGURE 2 How is the flow of water changing this landscape?

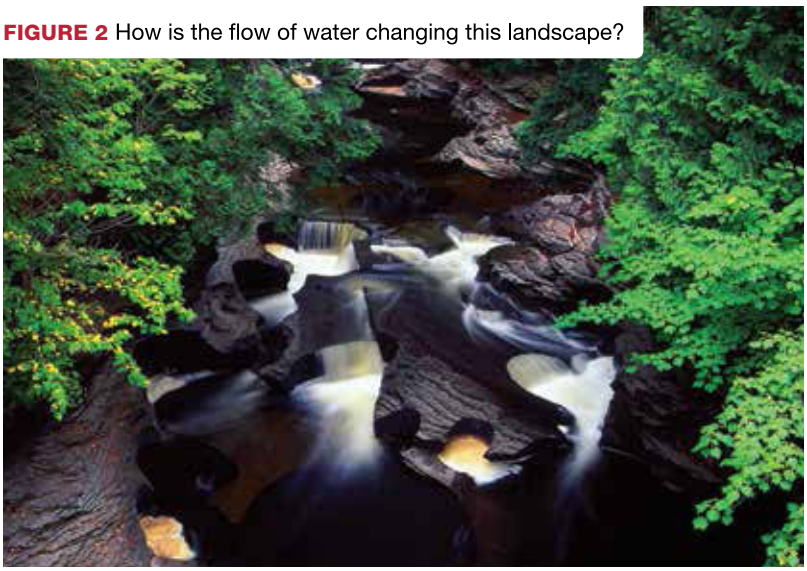
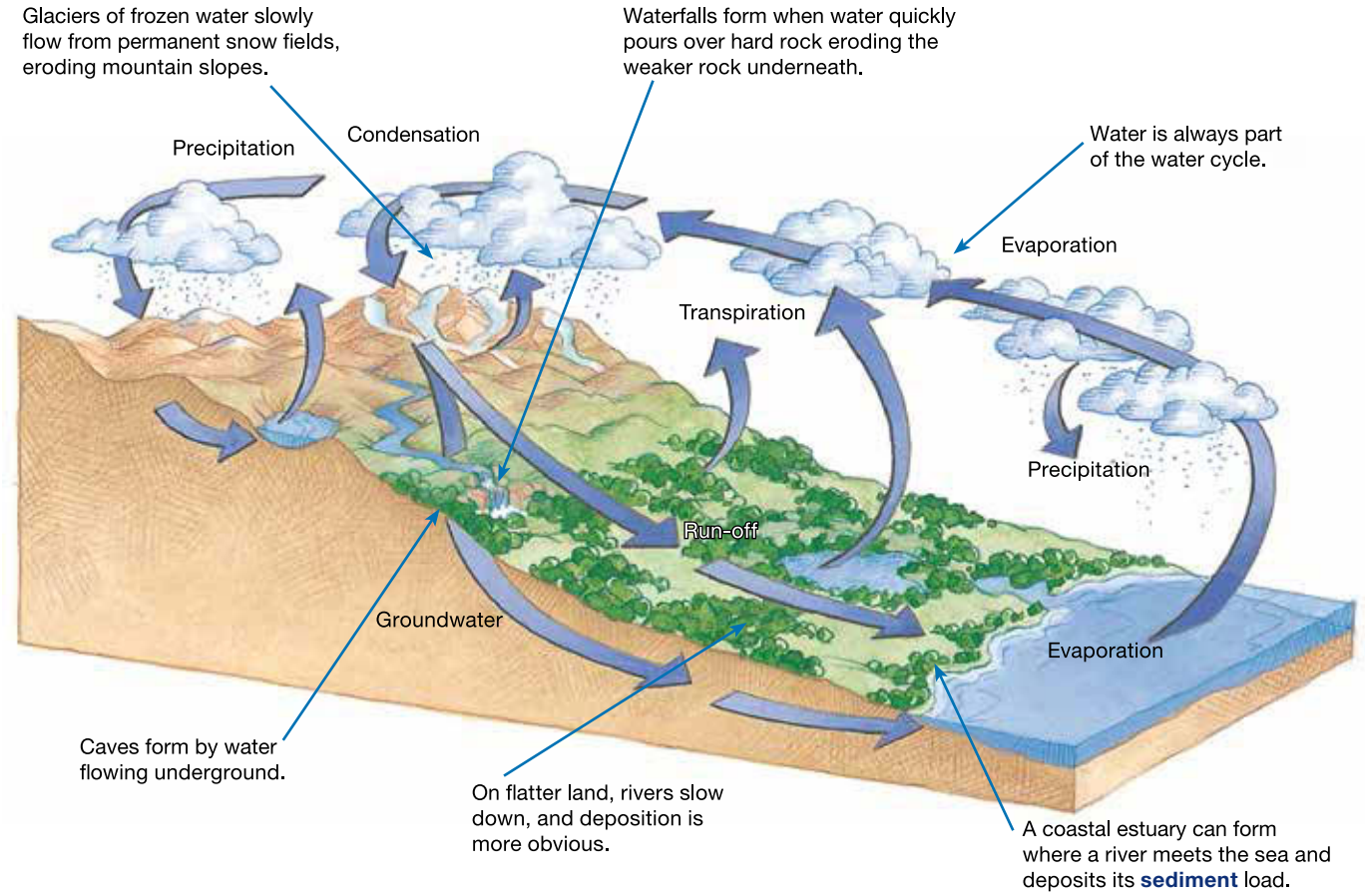


FIGURE 3 Water constantly moves over and through the Earth and through the air.



sediment material carried by water

ACTIVITIES

IDENTIFY

1 Landscapes are in a state of continual ***change***.
- **a** Which two natural processes powered by water are most responsible for continually ***changing*** landscapes?
- **b** How are these two processes linked?

EXPLAIN

2 Where would figures 1 and 2 be ***placed*** on the landscape depicted in figure 3? Explain.

3 Explain how the water cycle and the formation of landscapes are ***interconnected***.

INVESTIGATE

4 Using an atlas, Google Earth and other sources where appropriate, label on a world map each of the following:
- **a** the largest glacier
- **b** the longest river
- **c** the highest waterfall
- **d** the widest river
- **e** the largest ocean
- **f** the deepest point in an ocean
- **g** one other world water fact of your choice.

PREDICT

5 Many landscapes change rapidly; for example, the Twelve Apostles. With a partner or group, discuss another example of a landscape that has been shaped by the power of water. Do you think the ***changes*** to the landscape have been positive or negative? To what extent should people try to stop the ***changes*** caused by water?

6 Water can be considered one of the most important architects of desert landscape features. After looking at the images in this section, try to explain how you think water can ***change*** the landscapes of arid or desert ***environments***.

7 Identify three possible ways that people can ***change*** the flow of water, either across the surface of the Earth or along the coast. Predict how you believe this may alter landscape features. Examples may include the use of river water for irrigation or the construction of a marina.

2.8 How are landscapes created underground?

2.8.1 What is karst?

Apart from rivers and streams that flow across the surface of the Earth, vast networks of rivers also exist under the ground. The result is a network of caves and channels that carve a very different landscape, known as karst.

Karst is a landscape formed by water dissolving bedrock (solid rock beneath soil) over hundreds of thousands of years (see figure 1). On the surface of the Earth, sinkholes (holes in the Earth's surface), vertical shafts (tunnels), and fissures (cracks) will be evident. Rivers and streams may seem to simply disappear, but underground there are intricate drainage networks, complete with caves, rivers, **stalactites** and **stalagmites** (see figure 2).

Karst topography makes up about 10 per cent of the Earth's surface; however, a quarter of the world's population depends on karst environments to meet its water needs.

stalactite a feature made of minerals, which forms from the ceiling of limestone caves, like an icicle. They are formed when water containing dissolved limestone drips from the roof of a cave, leaving a small amount of calcium carbonate behind.

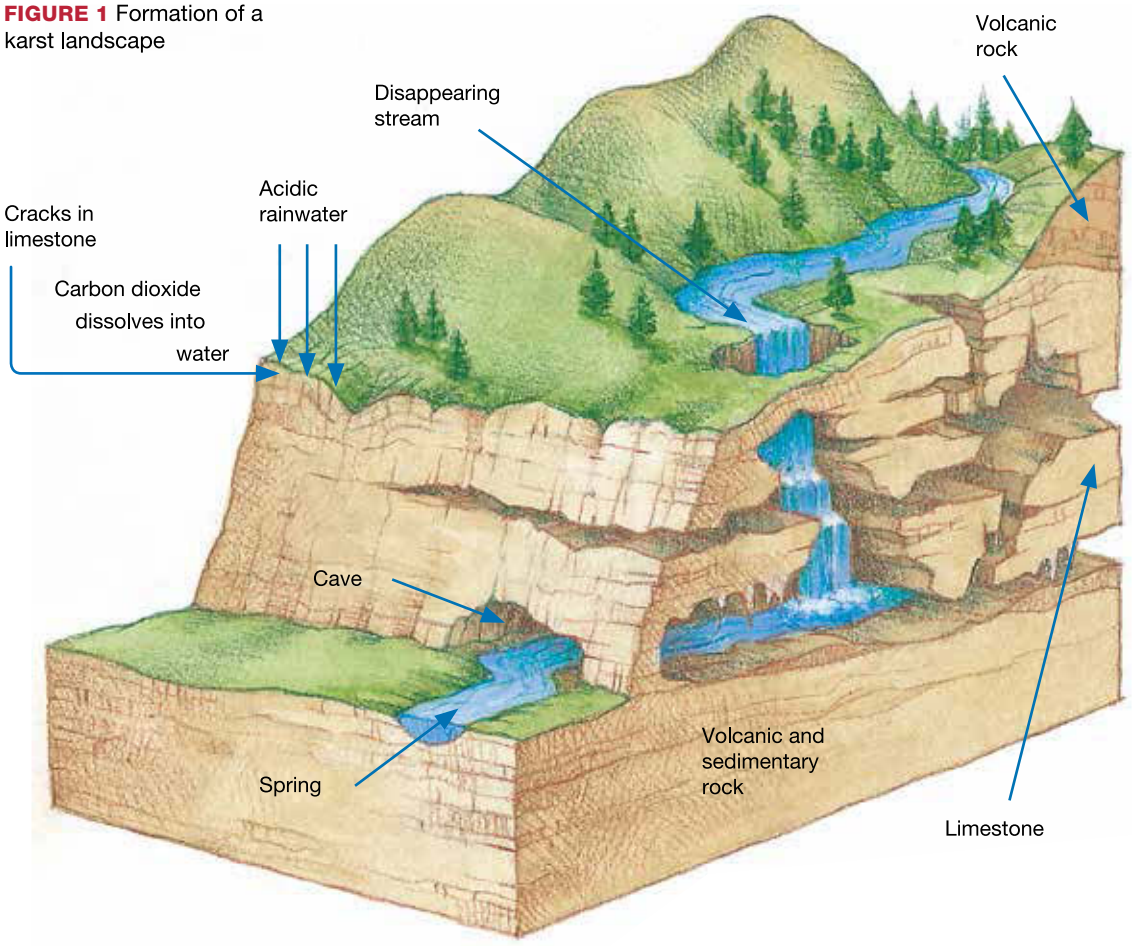
stalagmite a feature made of minerals found on the floor of limestone caves. They are formed when water containing dissolved limestone deposits on the cave floor and builds up.

soluble able to be dissolved in water

2.8.2 How are karst landscapes formed?

Water becomes slightly acidic when it comes into contact with carbon dioxide in the atmosphere (as it does when raindrops form) or when it filters through organic matter in the soil and percolates into the ground. Acidic water is able to dissolve **soluble** bedrock, such as limestone and dolomite. This creates cracks or fissures, allowing more water to penetrate the rocks. When the water reaches a layer of non-dissolving rocks, it begins to erode sideways, forming an underground river or stream. As the process

FIGURE 1 Formation of a karst landscape



continues, the water creates hollows, eventually creating a cave. Some karst landscapes contain aquifers that are capable of providing large amounts of water.

FIGURE 2 Caves in Guilin, Guangxi Province, southern China



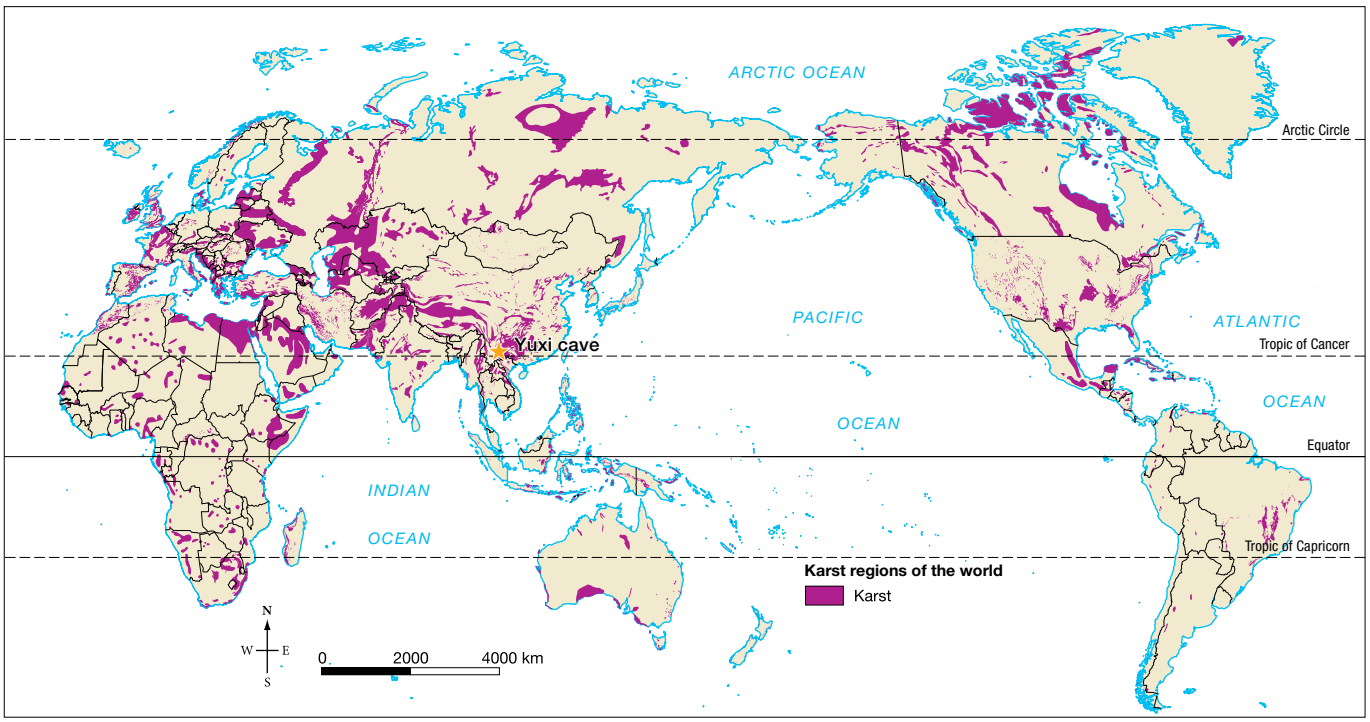
2.8.3 Where are karst landscapes located?

Karst landscapes are found all over the world, as shown in figure 3, in locations where mildly acidic water is able to dissolve soluble bedrock such as limestone and dolomite.

In tropical regions, where rainfall is very high, karst mountains sometimes develop. This is because the high rainfall levels wear away the soluble rock much faster than rock is worn away in karst areas with lower rainfall. Examples of tropical karst mountains include the peaks of Ha Long Bay in Vietnam and the Guilin Mountains in China.

The Earth's largest arid limestone karst cave system is located on Australia's Nullarbor Plain, covering 270 000 square kilometres. It extends 2000 kilometres from the Eyre Peninsula in South Australia to Norseman in the Goldfields–Esperance region of Western Australia, and from the Bunda Cliffs on the Great Australian Bight in the south to the Victoria Desert in the north. The extensive cave system provides a unique habitat for a variety of native flora and fauna. Within the caves are fossils that can reveal much about our distant past, along with important Aboriginal heritage sites.

FIGURE 3 Karst regions of the world



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 In your own words, explain how a karst landscape is formed.

EXPLAIN

2 Describe the global distribution of karst landscapes.

3 Do you think we should preserve karst landscapes? Give reasons for your answer.

INVESTIGATE

4 Examples of karst landscapes in Australia include the Buchan, Naracoorte, Jenolan, Labertouche, Princess Margaret Rose, Judbarra and Abercrombie caves. Working with a partner, investigate one of these karst landscapes and prepare an annotated visual display. On a map, show its absolute and relative location. Include information about its landforms, land use, concerns or threats to this environment, and what is being done to ensure sustainable management of the landscape. Share your findings with the rest of the class.

5 The largest limestone arid karst system is found on the Nullarbor Plain, Australia.

- **a** The Nullarbor Plain is an example of a desert landscape; suggest how an ***environment*** formed by water can occur in this location.
- **b** This cave ***environment*** is a popular destination for caving groups. Use the internet to investigate this ***environment*** and why people are attracted to it. Compare this ***environment*** to the one you studied in question 4. Pay particular attention to the *scale* and *change* that has occurred in each ***place***. Is one more fragile than the other? Explain. Suggest strategies for the ***sustainable*** management of karst in the Nullarbor.
- **c** Describe how you think this landscape would be different if it were located in Australia's tropical north.

eBookplus

Interactivity
Underground wonders
Use this interactivity to find out more about how karst landscapes form.
Searchlight ID: int-3103

eBookplus ONLINE ONLY

2.9 How are river landscapes created?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

2.10 How are coastal landscapes shaped by erosion?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

2.11 How are coastal landscapes shaped by deposition?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

2.12 How do I undertake coastal fieldwork?

2.12.1 Your fieldwork task

A fieldwork activity will allow you to put the knowledge you have gained in the classroom into practice.

Any coastal landscape would be suitable to investigate. Once a fieldwork site has been identified, there is quite a lot of planning that you should do before you get there.

What is your fieldwork task?

Your task is to identify the landforms and dynamic nature of a coastal landscape and to recognise and assess the influence of people on it.

In class

1. Prepare a base map of the fieldwork site or sites. On this base map, mark in the location of the coastal landscape's natural features (such as beach, rock, dunes, water, vegetation) and **human features** (such as seawall, groyne, steps, lawn, shelter, jetty). Using Google Maps or a topographic map is an excellent way of identifying the specific details of the coastal landscape.
2. Looking at the aerial shot on Google Maps will also allow you to see the pattern of the waves as they move to the shore. Does it look as if longshore drift is occurring on the day this image was taken?

human features structures built by people

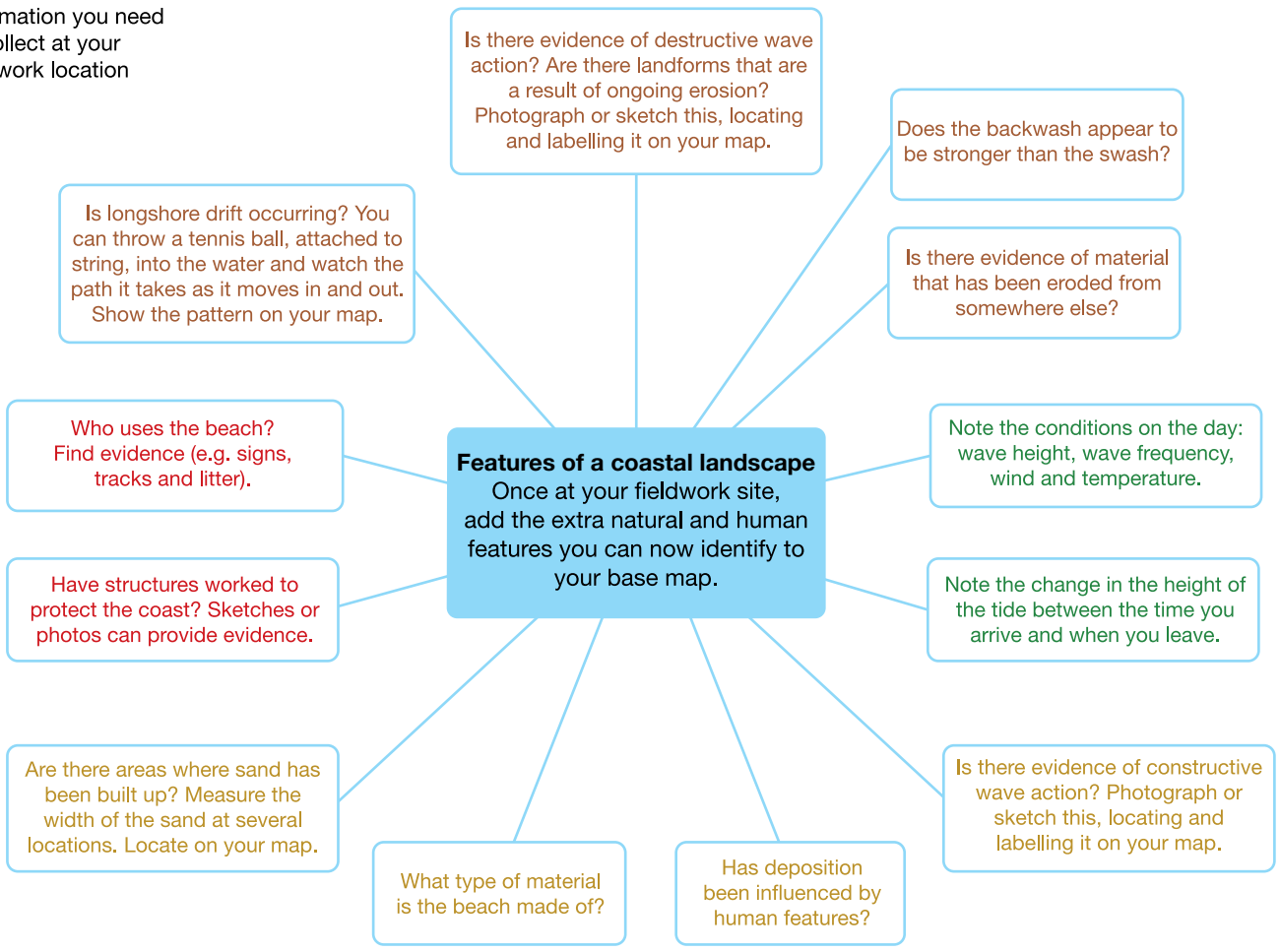


FIGURE 1 The information you need to collect at your fieldwork location

On your field trip

What do you need to do at the coast to collect your information?

It is good to work in groups to collect your data in the field. It is then possible for some students to take measurements and some to record. Sharing tasks means that there will be others with whom to discuss what you have recorded. On returning to class you can pool your observations. You will need recording sheets, pencils, a digital or phone camera, tape measure, compass and maybe a clinometer. You could also collect information using data logging equipment, a GPS locator, weather recording equipment and notepads. Your group should decide what equipment is the most practical and relevant for collecting the data you need.

You may not be able to return to your fieldwork site, which means your data needs to be very detailed.

- Always record the location of the information on your map.
- Take photos of the coastal landscape, including the landforms and human structures.
- Measure distances and heights.
- Draw **field sketches** to remind you of details. Even when you have photographed something, a field sketch allows you to annotate the diagram so that you can remember important characteristics about how it was formed or the direction of longshore drift. Do not worry if you are not a gifted artist, as there are apps that allow you to convert your photos to sketches when you get back to class.

field sketch
a diagram with geographical features labelled or annotated

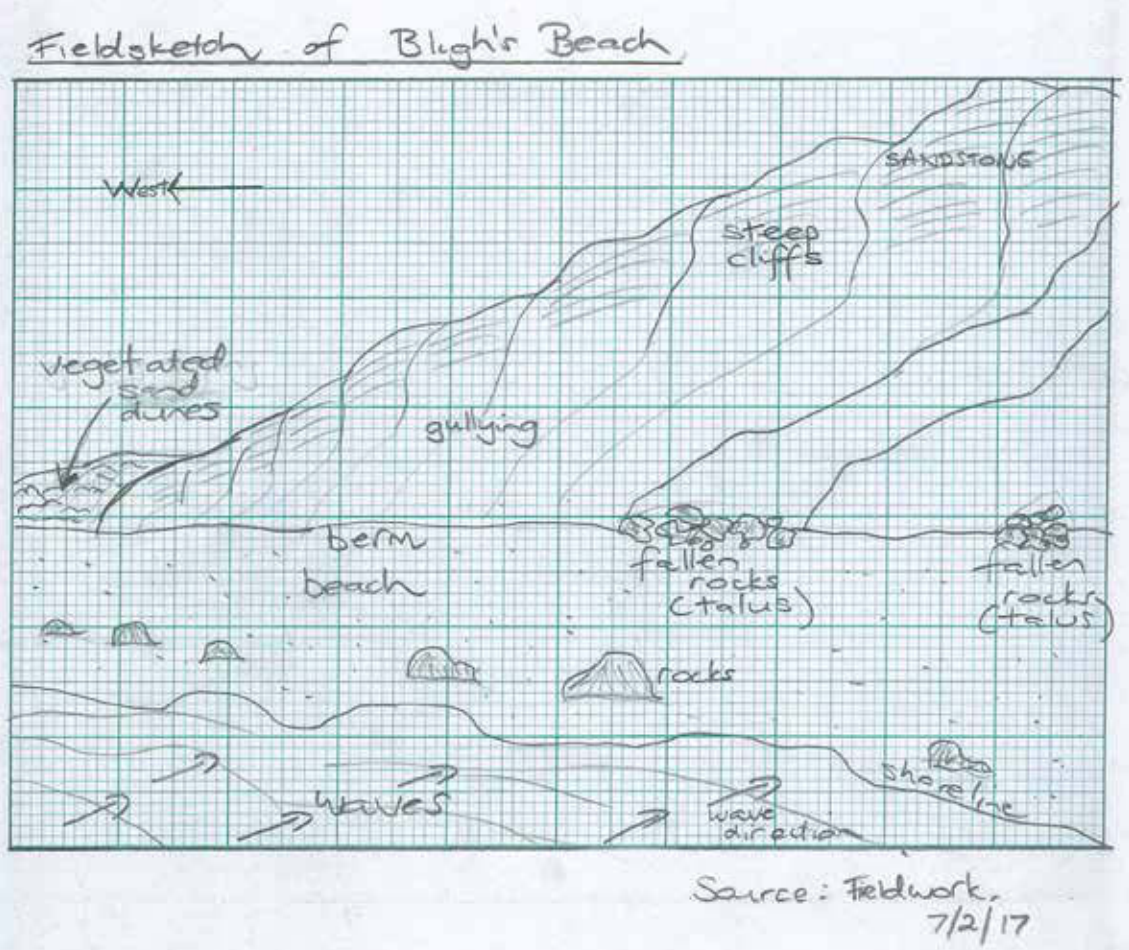
FIGURE 2 Investigating the rocky shores of a coastal landscape



Back in class

Now that you have collected your information in the field, you need to present your findings about the coastal landscape you visited.

FIGURE 3 A completed fieldwork sketch



There are many ways that you could present this information. Your fieldwork report could be presented as a poster, website, PowerPoint presentation, booklet, blog, movie, news report or podcast. Consider using Google Maps and uploading images of the sites you visited. You will need to present the data you collected and describe your findings.

FIGURE 4 Students on a fieldwork trip, measuring the slope of a sandy beach

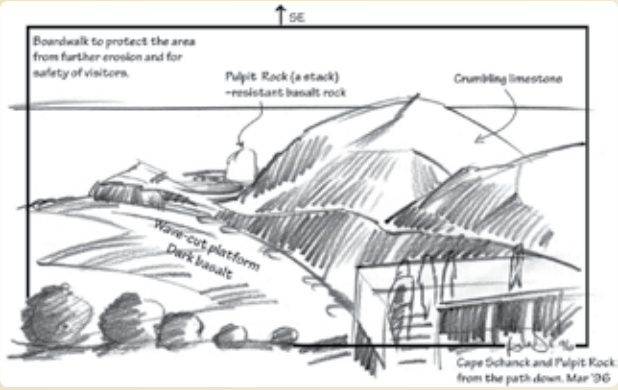


eBook*plus*
ONLINE ONLY

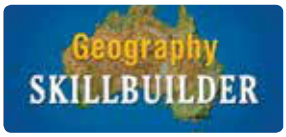
2.13 SkillBuilder: Constructing a field sketch

What are field sketches?

Field sketches are drawings completed during fieldwork — geography outside the classroom. Field sketches allow a geographer to capture the main aspects of landscapes in order to edit the view, focusing on the important features and omitting the unnecessary information.



eLesson
Watch this video to learn how to construct a field sketch.



Searchlight ID: eles-1650

Interactivity
Try this interactivity to learn how to construct a field sketch.



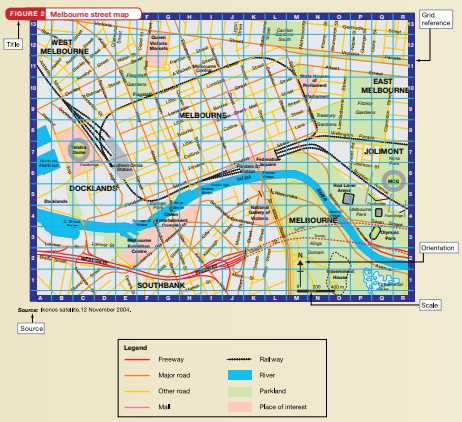
Searchlight ID: int-3146

eBook*plus*
ONLINE ONLY

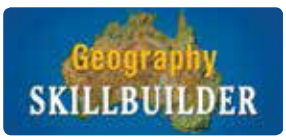
2.14 SkillBuilder: How to read a map

What is a map and why are they useful?

Maps represent parts of the world as if you were looking down from above. Maps are useful to show features so that we have a deeper understanding of places. When travelling, maps are essential to navigate unfamiliar places. All maps should have what we call BOLTSS.



eLesson
Watch this video to learn how to read a map.



Searchlight ID: eles-1634

Interactivity
Try this interactivity to learn how to read a map.



Searchlight ID: int-3130

2.15 What are topographic maps?

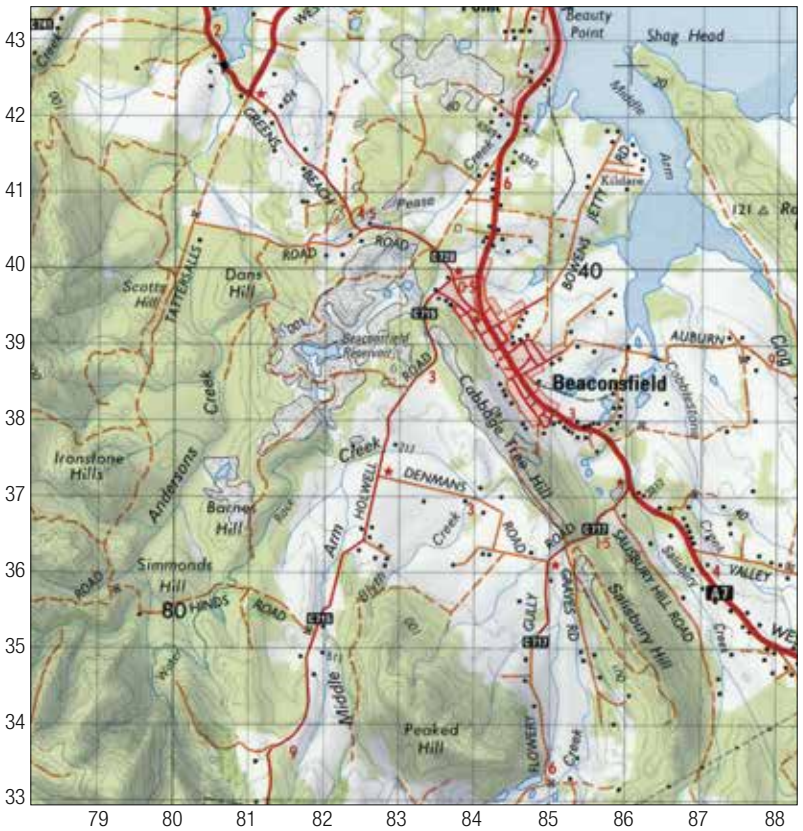
2.15.1 What is a topographic map?

A topographic map is a representation of the Earth which shows the features of a landscape. The map is overlaid with a coordinate grid.

2.15.2 What is shown on a topographic map?

- **Cultural features:** urban developments, buildings, borders and boundaries, and transportation infrastructure such as roads, bridges, airports and railways
- **Vegetation:** different types of vegetation such as grasslands, heathlands, peatlands, forests and woodlands
- **Water sources:** physical features related to water such as rivers, oceans, lakes and swamps
- **Relief:** the height of the land and different landforms such as mountains, slopes and depressions

FIGURE 1 Topographic map extract, Tamar Valley, Tasmania



2.15.3 How do you interpret a topographic map?

The basic features that help you read a topographic map are the border, orientation, legend, title, scale and source. This can be remembered with the acronym BOLTSS.

B	Border
O	Orientation
L	Legend
T	Title
S	Scale
S	Source

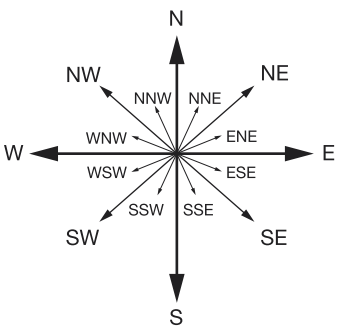
Border

The border defines the boundaries of the map face. Around the edges of the border you will find grid coordinates and possibly latitude and longitude references. The border outlines all the key features of the map.

Orientation

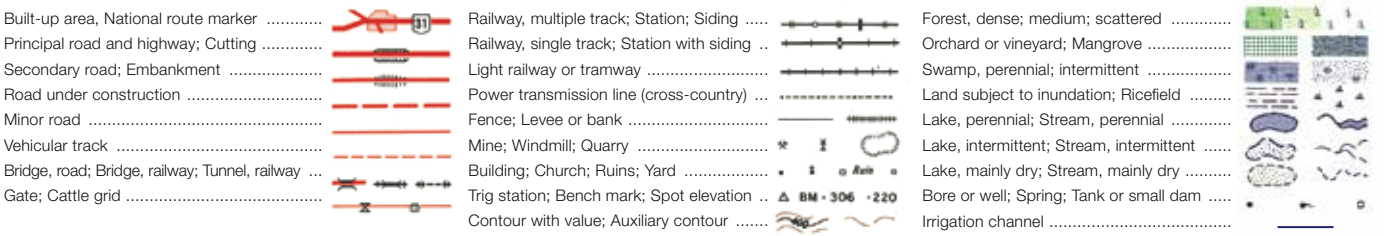
Direction is used to tell us the location of one place in relation to another. The four cardinal points are:

- North
- South
- East
- West.



Legend

The features shown on a topographic map are explained in a key or legend (see below). The key provides symbols with explanations.



Title

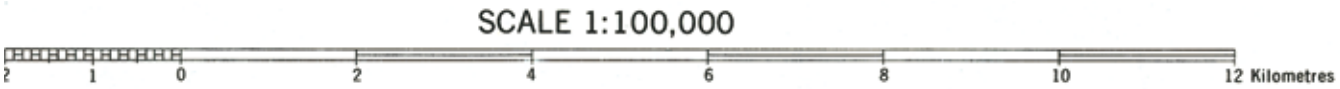
The title tells you the location of the map.

Scale

Scale describes the relationship between the size of an object in real-life compared to the size of an object on a map. Scale helps us to determine the distance of one location from another.

Scale can be shown in three ways.

Linear scale



Scale statement

A scale statement expresses the map scale in words. For example:

- One centimetre represents half a kilometre.

Scale as a ratio

A map scale may be expressed as the ratio of the distance on the map to the corresponding distance on the ground. For example:

- 1 : 50 000

The most common scale is 1 : 100 000. This means that 1 centimetre represents 100 000 centimetres, or 1000 metres or 1 kilometre; so, if you measure 4 centimetres on the map it will represent 4 kilometres on the ground.

Source

For Australian locations, many topographic maps are created by the state and federal governments of Australia. Others can be made by private companies. It is always important to examine the source of a map to ensure it is from a trusted source.

Map supplied by MAPLAND, Environmental and Geographic Information, Department for Environment and Heritage, South Australia.

contour line a line joining places of equal height above sea level

spot height a point on the map which shows the exact height above sea level at that place

2.15.4 Contour lines

Topographic maps enable us to understand the shape of the land even though they are shown in two dimensions (on a flat piece of paper).

Contour lines and **spot heights** help us to determine the altitude of different places on the map.

eBook*plus* ONLINE ONLY

2.16 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

2.4 SkillBuilder: Recognising land features

2.4.1 Tell me

What are land features?

Land features are landforms with distinct shapes, such as hills, valleys and mountains. You recognise these as you look around your natural environment. On topographic maps you recognise land features from the patterns formed by the contour lines.

Why is it useful to recognise land features?

By recognising land features, we understand our natural environment. This is useful for a wide range of activities including:

- planning housing estates, freeway routes and reservoirs
- organising outdoor recreational pursuits such as orienteering, trail-biking and flying
- managing hazards such as flooding.

Model

FIGURE 1 Landforms matched to a topographic map

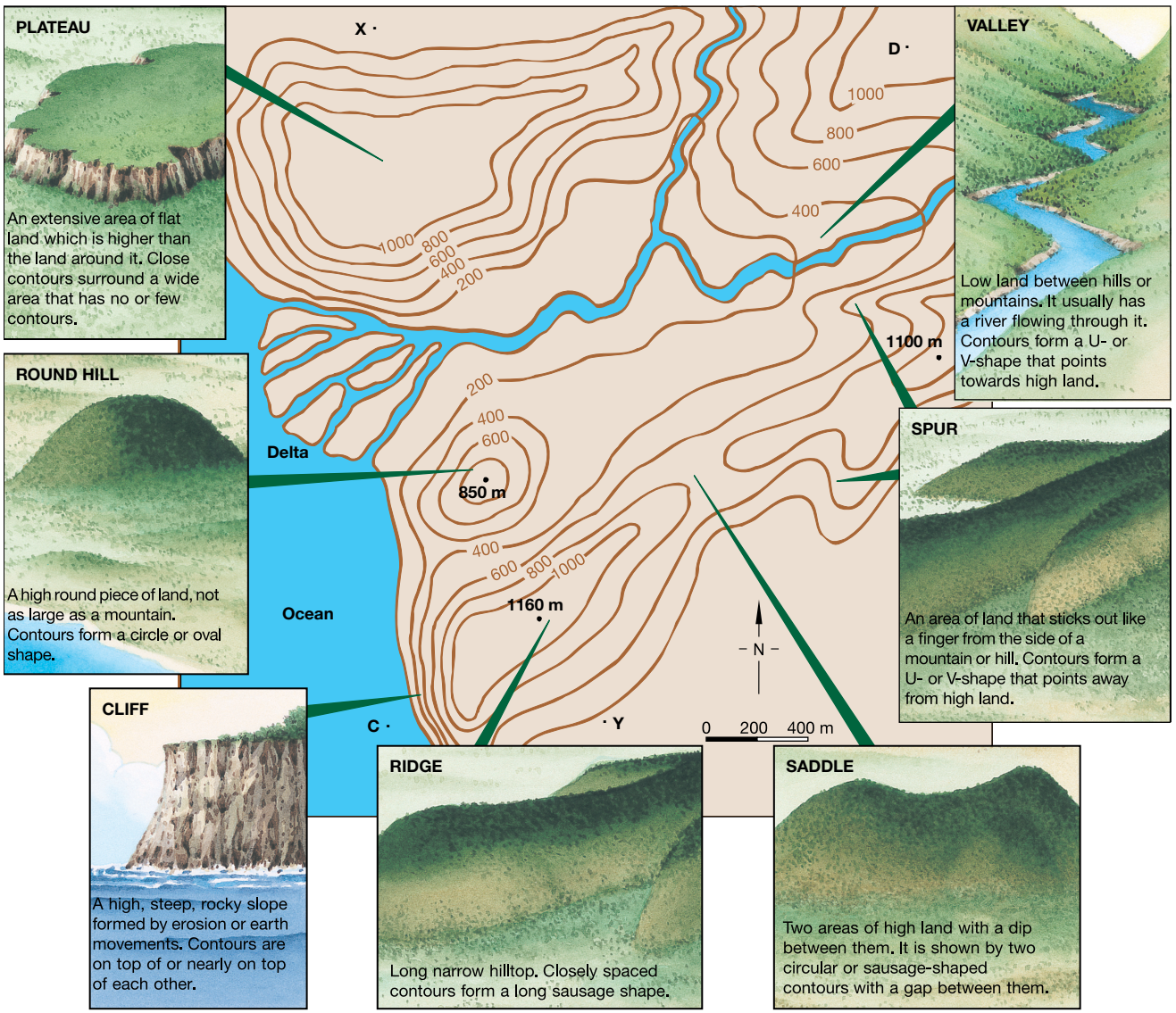


Figure 1 shows a simple topographic map including a spur, cliff, valley and plateau. These land features are identified by the way the contour lines come together to create shapes on the map.

Recognising land features on a map involves identifying the shapes created by the pattern of contours.

2.4.2 Show me

How to recognise a land feature

eBookplus

eLesson
Recognising land features
Searchlight ID: eles-1648

By reading the contour lines an understanding of the shape of the land is obtained. Land features are identified from the contour lines.

You will need:

- a topographic map.

Procedure:

Use the contour lines to identify land features.

STEP 1

Look at the contour lines on figure 1. You will see that sometimes the lines are close together and sometimes the lines are further apart. Identify two areas where this is the case.

STEP 2

Using your hand, create the shape of a hill. For every 50 metres increase of the hill slope, move your hand higher and at each step visualise that this is the next contour line on a map.

Try this for some other landforms that you are familiar with, such as a valley or a beach cliff.

Did you recognise that if the contours are close together then the shape of the land is steep, and if the contours are further apart then the land is flatter?

eBookplus

Interactivity
Recognising land features
Searchlight ID: int-3144

STEP 3

Landforms have distinctive shapes with contours, which a geographer recognises on a topographic map as a particular land feature. Use figure 1 as a guide to understanding the shapes on maps as land features. Create your own hand models of the shape of each land features.

2.4.3 Let me do it

Developing my skills

Use figure 2, the map of Yarra Yarra Creek basin, New South Wales, to identify the following landforms.

1. Ridge
2. Wide valley
3. Very steep slope
4. Spot height of 635 metres
5. Spur
6. Plateau
7. Saddle

Questions

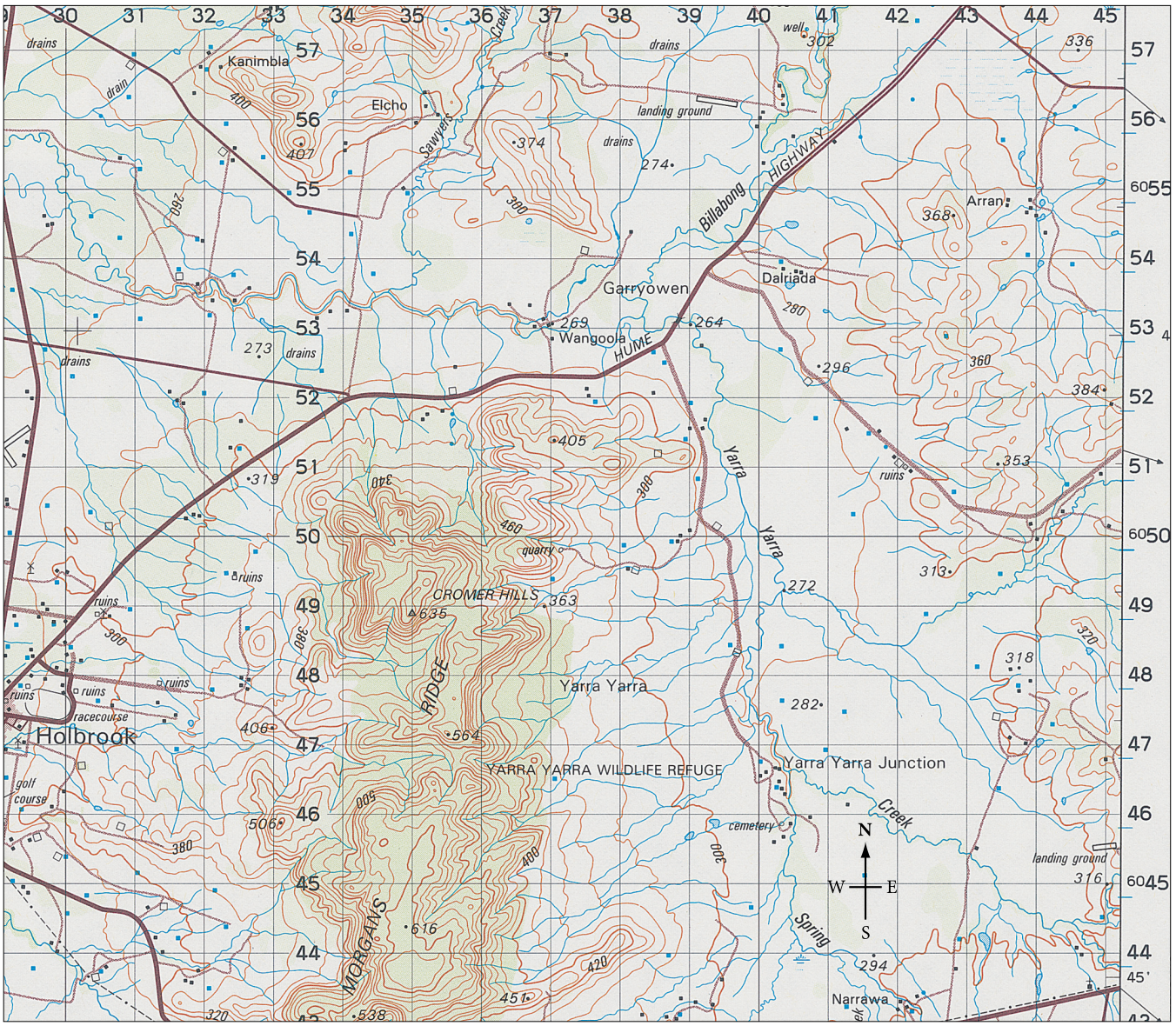
1. Which slope of Morgans Ridge would be the most difficult to climb?
2. What two natural features can be seen from Morgans Ridge to the east?
3. What are the heights of the peaks on Morgans Ridge?
4. Can you see the town of Holbrook from Wangoola? Explain your answer.
5. What land features form part of Morgans Ridge?

Checklist

I have:

- recognised the major land features on a topographic map.

FIGURE 2 Topographic map of Yarra Yarra Creek basin



SCALE 1:100 000

kilometres 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 kilometres

CONTOUR INTERVAL 20 METRES

ELEVATIONS IN METRES

LEGEND

- Built-up area; Divided highway; Metropolitan route marker
- Recreation reserve with oval; Drive-in theatre; Underpass
- Sealed road two or more lanes; National route marker
- Sealed road one lane; Embankment
- Unsealed road two or more lanes
- Unsealed road one lane; Cutting
- Vehicle track; Road bridge; Gate; Stock grid
- Foot track; Foot bridge
- Multiple track railway; Station
- Single track railway; Light railway
- Railway tunnel, bridge, underpass
- High voltage transmission line
- Fence; Prominent telephone line
- Mine; Windmill; Church; Building; Yard
- Horizontal control point; Spot elevation
- Contour with value; Supplementary contour
- Depression contour; Sand; Distorted surface
- Levee, bank or sand ridge; Joint or rock fissure
- High cliff; Escarpment
- Vegetation; Dense, medium, scattered
- Vegetation distinctive; Distinctive grass
- Orchard or vineyard; Line of trees or windbreak
- Mangrove swamp; Area subject to inundation
- Swamp; Swamp definite boundary
- Perennial lake; Watercourse
- Intermittent lake; Watercourse
- Mainly dry lake; Watercourse
- Tank or small dam; Perennial waterhole
- Saline coastal flat; Intertidal flat
- Navigation light; Intertidal ledge or reef
- Pier; Exposed wreck; Prominent submerged wreck
- Prominent submerged reef, rock
- Indefinite watercourse, shoreline; Rock bare or awash

Source: Spatial Vision

Skills questions

1. Land features on a topographic map can be identified by:
   a. spot heights
   b. symbols
   c. labels
   d. shapes made from contour lines.
2. Contour lines very close together indicate:
   a. a gentle slope
   b. a cliff
   c. a valley
   d. a hill.
3. How do contour lines help to identify land features?
4. Why do geographers draw diagrams of land features?

2.5 What types of landscapes are found in the Pacific region?

2.5.1 What is the Pacific landscape like?

The Pacific Ocean is the world's largest ocean, and occupies almost a third of the Earth's surface, making it larger than all the Earth's land areas combined. It stretches from the Arctic in the north to Antarctica in the south and is bordered by Australia and Asia in the west and the Americas in the east. The 25 000 Pacific Islands of Polynesia, Micronesia and Melanesia (including Papua New Guinea) are home to around 10 million people.

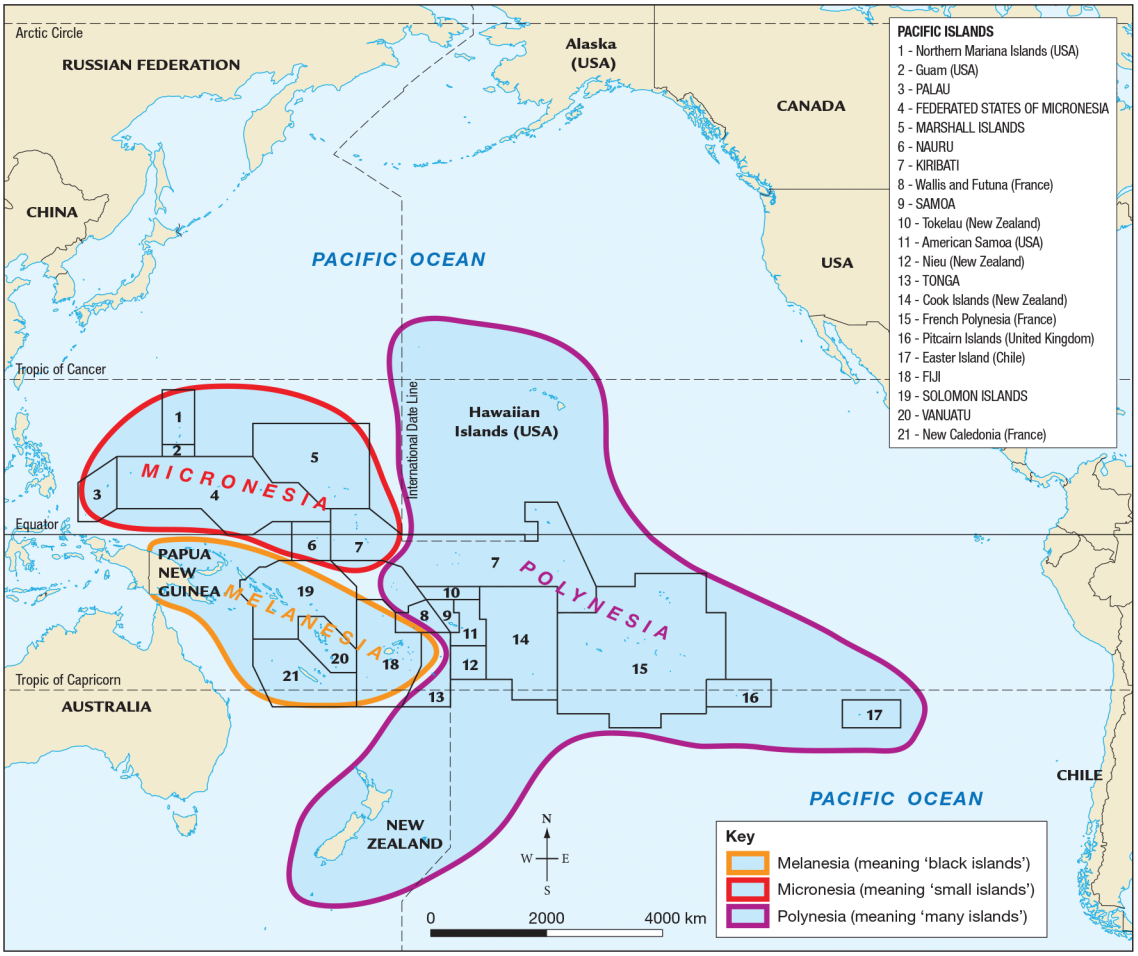
The Pacific islands are broken up into three main island groups (see figure 1).

Melanesia extends north and north-east of Australia, from the west Pacific Ocean to the Arafura Sea. It includes the islands of New Guinea (the nation of Papua New Guinea and the Indonesian province of Papua), New Caledonia, Vanuatu, Fiji and the Solomon Islands.

Micronesia has hundreds of small islands and is located north-east of Papua New Guinea. It is bounded by the Philippines in the west, Indonesia in the south-west and Melanesia to the south. Micronesia includes the Northern Marianas, Guam, Palau, the Marshall Islands, Kiribati, Nauru and the Federated States of Micronesia.

Polynesia forms a triangle, with its three corners at Hawaii, New Zealand and Easter Island. There are around 1000 islands in this part of the central southern Pacific Ocean. The other main islands are Samoa, Tonga, French Polynesia, Tuvalu and the Cook Islands.

FIGURE 1 The Pacific Ocean



Source: Spatial Vision

2.5.2 What records does the Pacific hold?

Apart from being the world's largest ocean, the Pacific holds a number of other records.

- At 10 203 metres, Mauna Kea in Hawaii is the highest mountain from base to summit.
- Mauna Loa is the world's largest active volcano. It is 120 kilometres long and 50 kilometres wide. It has been active for over 700 000 years and will most likely continue to erupt for another 500 000 years.
- The Mariana Trench in the western Pacific is the deepest point on Earth — 11 032 metres.
- Australia's Great Barrier Reef is the world's largest coral reef, stretching some 2027 kilometres.
- Kwajalein in the Marshall Islands, with a length of 125 kilometres, is the world's largest **coral atoll**. It actually comprises 97 islands and **islets** and surrounds one of the world's largest **lagoons**, covering 2173 square kilometres.
- Grand Lagoon Sud in New Caledonia is the world's largest lagoon, covering an area of 3145 square kilometres.
- The Pacific Ocean is encircled by the Pacific Ring of Fire, the world's most active tectonic region. Approximately 75 per cent of the world's active volcanoes and 90 per cent of the world's earthquakes are here.

coral atoll a coral reef that partially or completely encircles a lagoon

islets a very small island

lagoon a shallow body of water separated by islands or reefs from a larger body of water, such as a sea

2.5.3 What are low islands?

Some of the low islands in the Pacific are the remains of volcanoes that have eroded over time and are now only just above sea level. Examples include some of the smaller islands in Hawaii and Bora Bora in French Polynesia.

Other low islands are reefs, or atolls built on coral reefs, and are usually quite small, some barely reaching above sea level. Low islands are often a series of very small islands and islets with a lagoon at their centre, known as atolls.

Some coral atolls were built by volcanic activity millions of years ago. Eventually, when the volcanic island erodes, it leaves a lagoon in its place.

Micronesia and Polynesia are dominated by low islands. Mount Orohena and Mount Aorai on the island of Tahiti and Mount Tohiea on the island of Moorea (both in French Polynesia) are examples of old volcanoes. They have fringing reefs surrounding a shallow lagoon formed when the island was eroded. These reefs have become barrier reefs that protect the island and the lagoon from the force of the ocean waves.

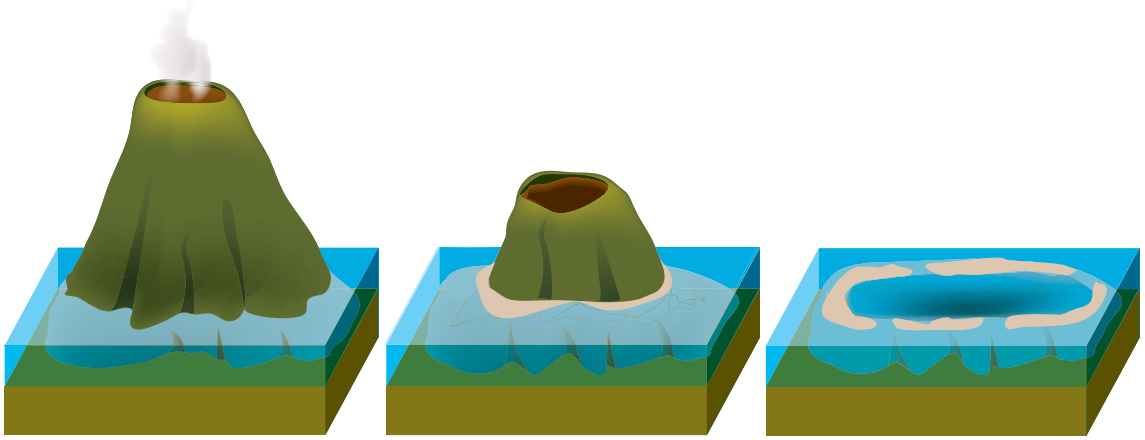
Coral atolls have no rivers, and the soil is generally thin and not very fertile. Some low islands receive high rainfall, and have more fertile soils that can sometimes support forests.

FIGURE 2 The volcanic island of Moorea, French Polynesia, surrounded by a fringing reef



Source: © Yann Arthus-Bertrand/Corbis

FIGURE 3 Development of lagoons and fringing reefs



Coral colonises the sides of a volcano, forming a reef.

The volcano cools over thousands of years; the volcano starts to sink and its summit is eroded.

Eventually the volcano disappears from view and a lagoon forms in the area once occupied by the volcano.

2.5.4 What are high islands?

A number of the high islands in the Pacific were once part of either the Australian or Asian continents. These include New Zealand, New Guinea and most of the islands in Melanesia.

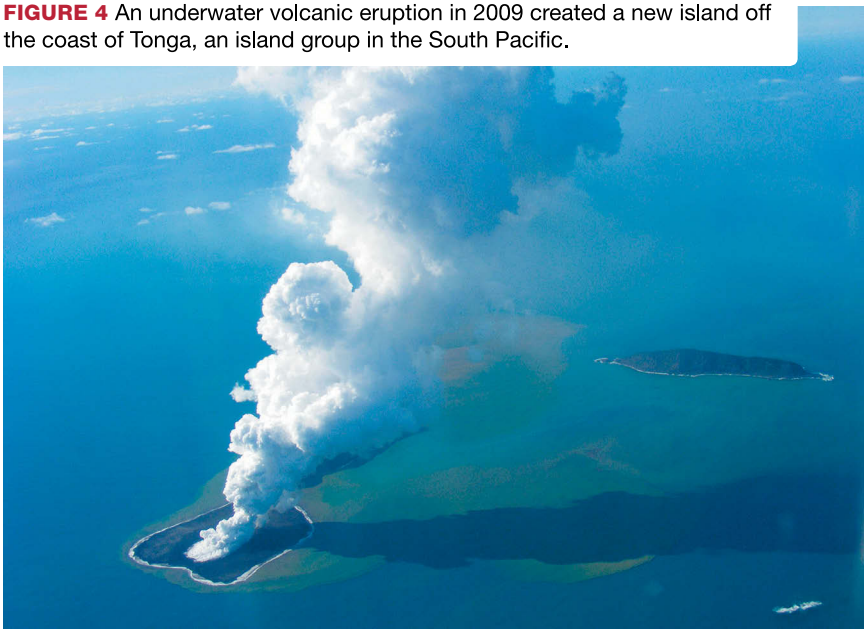
Other high islands are volcanic and are really the tops of undersea mountains. They are made up of magma that was forced up through fissures (cracks) in the ocean floor before being cooled by sea water and hardening. Many of the islands found in Micronesia and Polynesia were formed in this way. Sometimes volcanic islands are formed in a chain called an archipelago.

New Zealand has more than 200 islands and 220 mountains higher than 2300 metres, the highest being Mount Cook at 3754 metres.

New Guinea is also mountainous. It has a central spine formed by high mountain ranges, the highest of which is Puncak Jaya at 5030 metres. Tahiti, Fiji, Vanuatu, the Caroline Islands and Raratonga in the Cook Islands are also volcanic islands.

Many large rivers flow from these high mountains, including the Fly River in Papua New Guinea, the Waikato in New Zealand, and the Rewa and Sigatoka Rivers on Viti Levu in Fiji. Many high islands have fertile volcanic soils that support a variety of vegetation types, including rainforest, mangrove forests and palms.

FIGURE 4 An underwater volcanic eruption in 2009 created a new island off the coast of Tonga, an island group in the South Pacific.



Source: © AFP/Getty Images

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Pacific nations

ACTIVITIES

IDENTIFY

1 Explain the difference between low islands and high islands.

2 Explain the ***interconnection*** between the Pacific landscape and tectonic activity.

EXPLAIN

3 a Which island groups in the Pacific Ocean are dominated by low islands and which are dominated by high islands?

b Do any of the island groups contain both low and high islands? If so, which ones?

c Make your own sketch of a Pacific island and annotate your sketch to show how this ***place*** might ***change*** over time. Indicate the type of island you are describing.

4 More people in the Pacific islands live on the larger volcanic islands in Melanesia than in other parts of the Pacific. Suggest two reasons why this might be the case.

INVESTIGATE

5 Pacific islands are popular tourist destinations. Have each member of your class investigate a different island as a possible holiday destination. Prepare an itinerary for a one-week holiday. Include information about the formation, landforms and culture of the island as well as activities that might be undertaken by a tourist.

6 Use an atlas to locate 10 of the ***places*** and features mentioned in this subtopic. Use direction, latitude and longitude to create a 'What am I?' or 'Where am I?' puzzle. Swap your quiz with another member of the class and see if they can solve your puzzle.

2.9 How are river landscapes created?

2.9.1 Moving water

Erosion, transportation and deposition by running water are the main processes that create our landscapes. Some rivers, such as the Gordon River in Tasmania, are **perennial**; some, such as Coopers Creek in Queensland, are **intermittent**; others, such as the Colorado River in the United States, have eroded amazing landforms like the Grand Canyon.

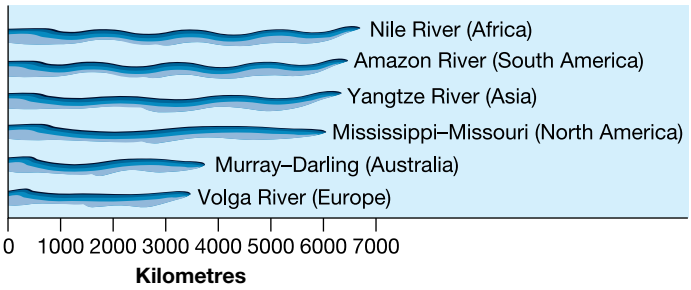
perennial describes a stream that flows all year

intermittent describes a stream that does not always flow

Water is always on the move. It evaporates and becomes part of the water cycle; it rains and flows over the surface of the Earth and into streams that make their way to a sea, lake or ocean; and it soaks through the pores of rocks and soil into **groundwater**.

groundwater water that seeps into soil and gaps in rocks

FIGURE 1 Rivers of the world: the longest river on each continent.



2.9.2 River systems and features

A river is a natural feature, and what we see is the result of the interaction of a range of inputs and processes. All parts of the Earth are related to the formation of river landscapes. This includes the lithosphere (rocks and soil), the hydrosphere (water), the biosphere (plants and animals) and the atmosphere (temperature and water cycle). Changes can happen quickly and over a very long period of time. Changes at one location along a river can have an effect at other locations along the river.

Water flows downhill, and the source (the start) of a river will be at a higher altitude than its mouth (the end). As the water moves over the Earth's surface, it erodes, transports and deposits material.

The volume of water and the speed of flow will influence the amount and type of work carried out by a river. A fast-flowing flooded river will erode enormous amounts of material and transport it **downstream**. As the speed or volume of the water decreases, much of the material it carries will be deposited.

downstream nearer the mouth of a river, or going in the same direction as the current

FIGURE 2 A river system

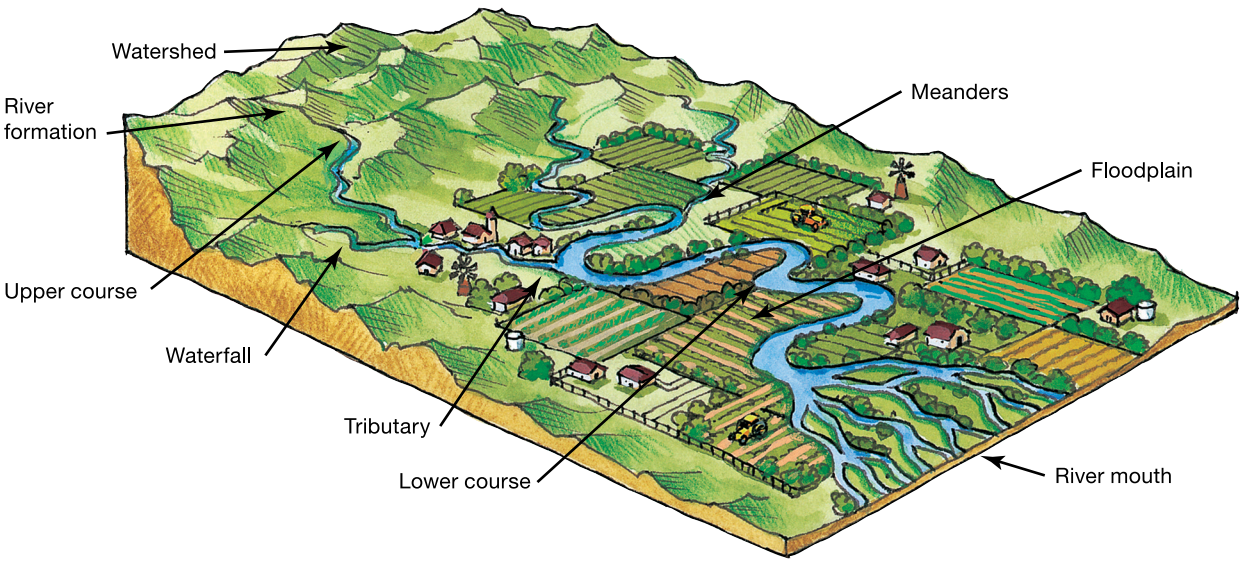
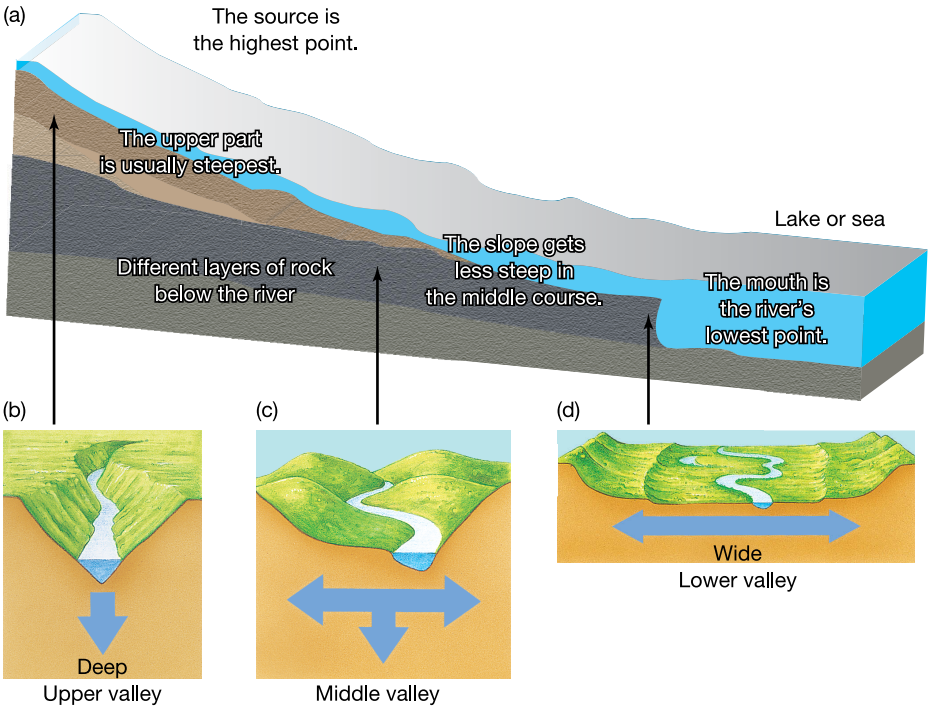


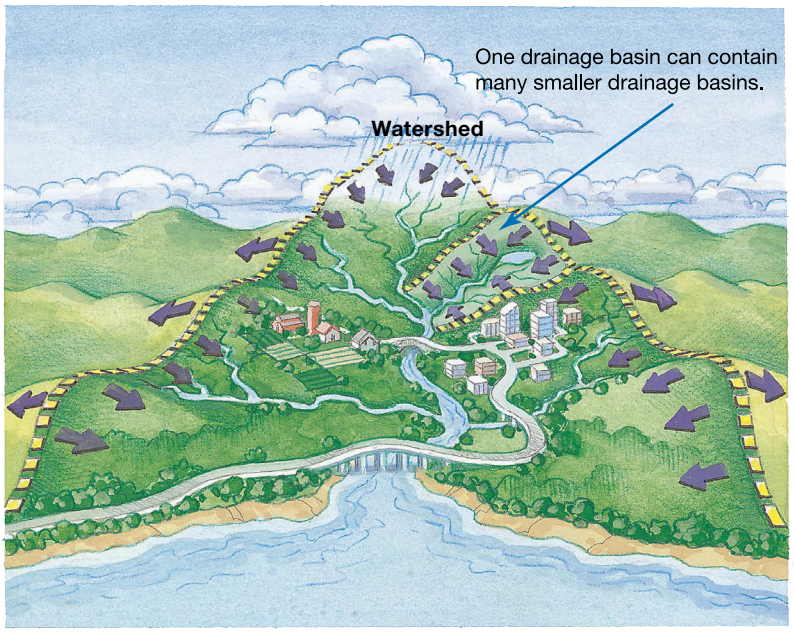
FIGURE 3 (a) Long profile of a river — a view along its length. The slope of the river tends to get flatter and the riverbed gets smoother as it moves downstream.
(b)–(d) Cross-sections showing the shape of the river channel and valley at three points along the river. Arrows indicate the main direction of erosion.



Watershed

A river gathers its water from a region known as its drainage basin, or catchment (figure 4). The boundary of this region is identified by mountain tops, hilltops or any land that is slightly higher than surrounding land. This is known as the watershed, and it is the point that divides the direction of water flow.

FIGURE 4 The watershed and catchment, or drainage basin, of a river system



Source: Adapted from an image by RecycleWorks www.RecycleWorks.org

River formation

Even the biggest rivers begin with water from rain or melting snow in mountains or hills. This water has collected in tiny depressions called rills. These rills grow larger when they collect more water, and when they combine they begin to look like streams. Many streams contribute to a river (see figure 2).

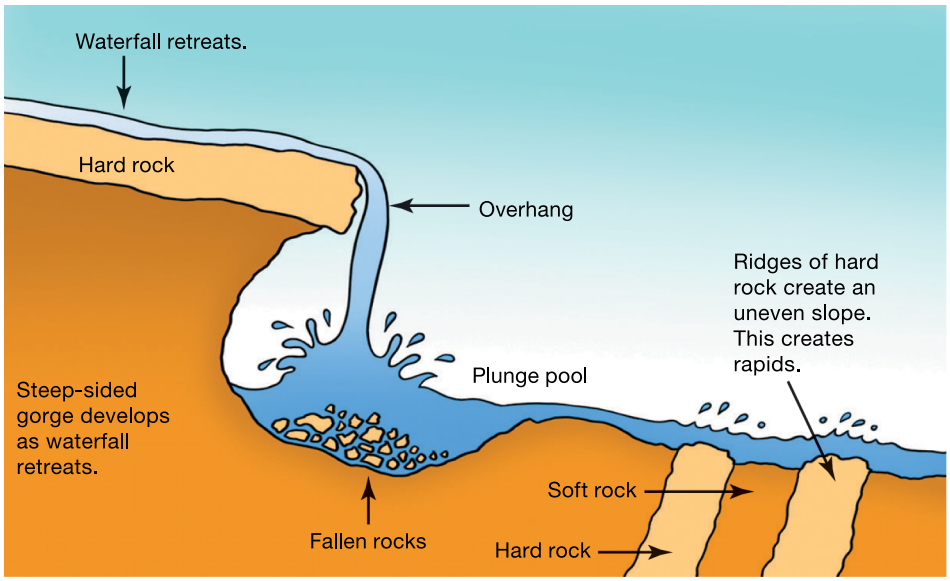
Upper course

Waters in a river channel flow over steeper slopes in the upper reaches. The force of rushing water on a steep slope cuts downwards and creates a V-shaped valley. The river then tends to follow a fairly straight course (see figure 3).

Waterfall

When a river meets resistant rock, a waterfall can occur (see figure 5). If the river has to cross bands of resistant rock, rapids will form. The turbulent water flow in rapids is called white water. A plunge pool forms at the base of a waterfall when rocks and soil moved by the fast flowing water erode the banks and base of the river.

FIGURE 5 A waterfall



Tributary

A river or stream that adds or contributes water to the main river is known as a **tributary** (see figure 6). The place where two rivers join is called the confluence.

tributary river or stream that flows into a larger river or body of water

Meanders

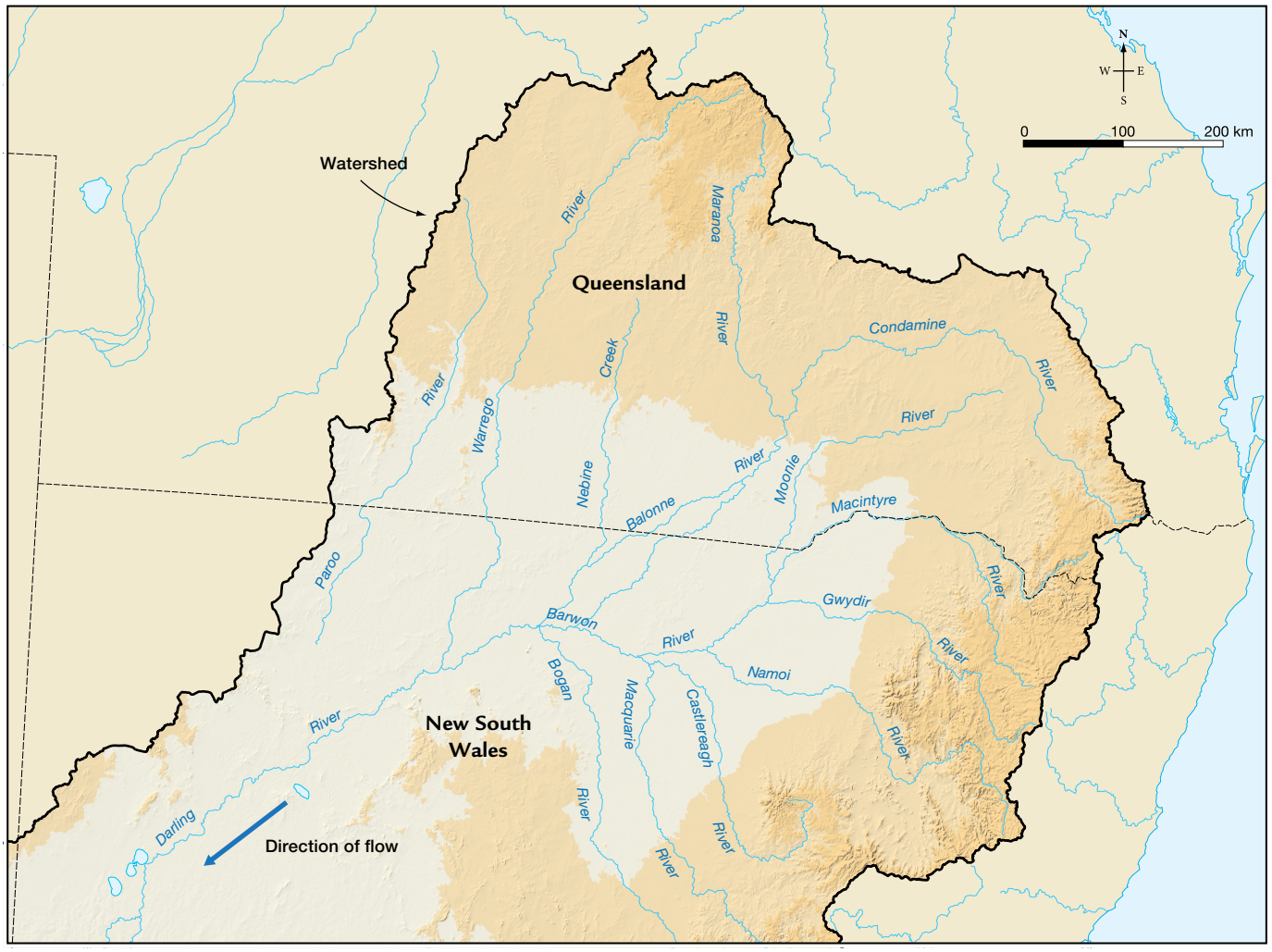
On flatter land, a river is wider than it is in the hills, and water added from tributaries has increased its volume (see figure 3). Much of the erosion is in a sideways direction, and the valley of a river is much wider. Sideways erosion causes meanders (curves) along its course (see figure 7). Over time, a meandering river will change the path it follows, as some bends become more obvious and some disappear. A meander that is cut off is called an oxbow lake.

Floodplains

Flooding over thousands of years creates floodplains. During a flood, the water flows over the banks of the river. Once outside the river, it slows down and deposits the **alluvium** it was transporting. This alluvium is often very fertile (see figure 2). These regions are highly suitable for farming and settlement (see figure 8).

alluvium sand, silt, clay and gravel beeing transported in flowing water

FIGURE 6 Tributaries of the Darling River which, in turn, is a tributary of the Murray River



Source: Spatial Vision

FIGURE 7 The formation of a meander and oxbow lake

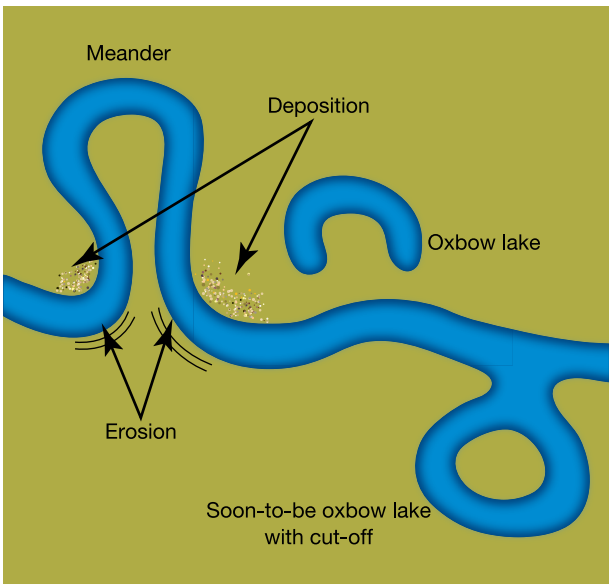


FIGURE 8 Murray River meanders



River mouth

Deltas are found at the mouths of large rivers, like the Mississippi. A delta is formed when the river deposits its material faster than the sea can remove it. The material is a mix of mud, sand and clay. The river will sometimes split up into smaller streams to find its way through the deposited material. These little streams are called distributaries. We recognise three main shapes of delta: fan shaped, arrow shaped and bird-foot shaped. The shape is influenced by tides, ocean waves and the volume of sediment and river water.

Sometimes a river will have a wide mouth, where fresh water and salt water mix. This is known as an estuary.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. ⊙ Norway's fjords

eBookplus

Interactivity
River carvings
Searchlight ID: int-3104

ACTIVITIES

IDENTIFY

1 Refer to figure 1 and compare the ***scale*** of Australia's longest river with the world's longest river.
2 Sketch the long profile shown in figure 3 and label the source, the mouth and the direction the river flows.
3 What feature, other than water, has to be present for waterfalls and rapids to form? Refer to figure 5.

EXPLAIN

4 Explain how rivers are part of the water cycle.
5 Why do people settle and farm on floodplains?

INVESTIGATE

6 Identify a river that flows through the capital city in one state or territory in Australia. Describe its source, any tributaries, and its mouth.
7 After some rain, investigate an area of bare ground on a small slope near school or home. Sketch the pattern that the rills have made. Identify the watershed and catchment for each rill.
8 Using Google Earth or an atlas, find the Nile delta, the Ebro delta and the Mississippi delta. Draw a sketch and write a short description of the shape of each delta, presenting your findings in a table.

PREDICT

9 Refer to figure 8. Sketch a diagram to show the course of the meandering Murray River. Mark in the course that the river used to take. Predict and label where the next oxbow lake might form. Show the possible future course of the river.
10 What do you think will happen to deltas if sea levels rise?
11 Predict the ***changes*** that will occur to the waterfall in figure 5. Justify your answer.

APPLY

12 Produce a flowchart or animation to explain the formation of an oxbow lake, a delta, a waterfall or rapids.
13 Refer to the paragraph about meanders and to figures 3 and 7. Sketch a cross-section (like figure 3) of a river at a meander. This will show the shape of the riverbank on each side of the river. What are the advantages and disadvantages of living on each side of the river?
14 What ***changes*** will occur along a river if there is unusually high rainfall in its upper course? Think in terms of erosion and deposition.

2.10 How are coastal landscapes shaped by erosion?

2.10.1 How are coastal landscapes eroded?

The coast is the zone or border between land and ocean. It is in this collision zone that the movement of sea water and the impact of the ocean on the land together create coastal landscapes. Coastal landscapes have landforms that are common to coastlines in different places around the world because they are built up or worn away in similar ways.

Powerful ocean waves crash onto rocky coastlines, wearing away the cliff base between the high and low tide marks. In figure 1 in subtopic 2.7, showing the Twelve Apostles, the most powerful wave impact on this coast would be to the seaward side of the stacks or rock pillars. Wave impact has progressively knocked over some stacks, and the rock that they were made from has eroded into sand, which now forms part of the beach at the cliff base.

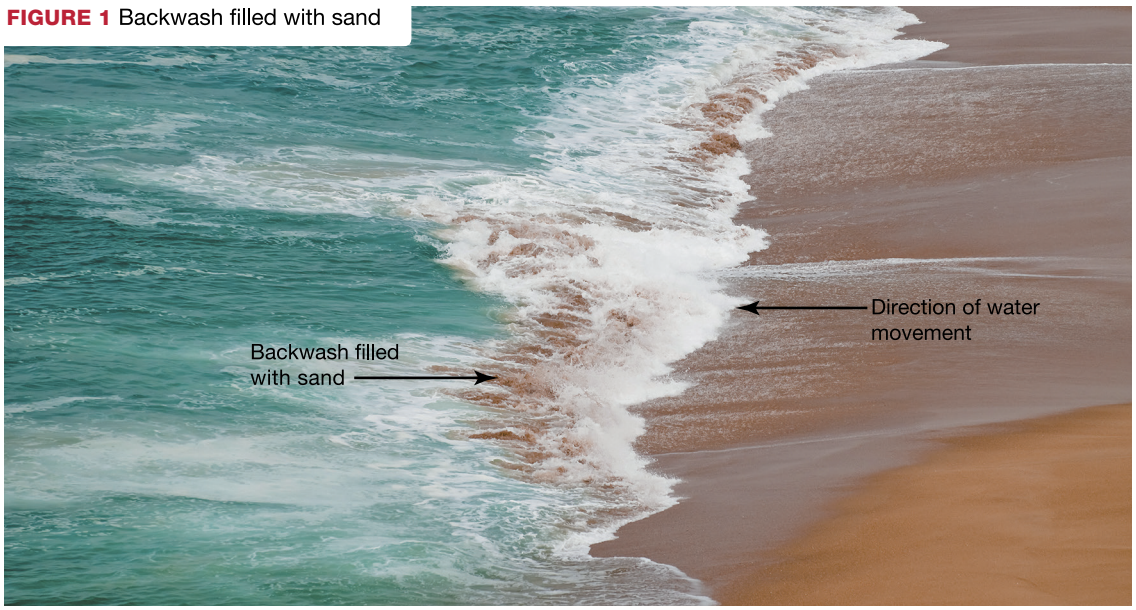
Coastal erosion is mostly caused by waves moving sand and other material and energy to and from the beach. For example, you may have seen sand being churned up by the waves when you have been at the beach. The waves that wash on to the beach are called **swash**. Waves returning down the beach into the sea are called **backwash**. A powerful ocean swell created by offshore storms forms **destructive waves**. These are the waves that produce good surf, and dump you while you are swimming. As these waves rush back into the sea, the force of the water and sand they carry can make it difficult for you to get back onto the beach. Destructive waves often have a powerful backwash that can carry beach sand offshore. Figure 1 shows backwash filled with sand that is being moved from the beach.

swash the movement of water in a wave as it breaks onto a beach

backwash the movement of water from a broken wave as it runs down a beach returning to the ocean

destructive waves a large powerful storm wave that has a strong backwash

FIGURE 1 Backwash filled with sand



However, not all aspects of coastal landscapes are solely created by the power of water. Other physical processes can also greatly affect the coastal landscape; for example, the tectonic force of earthquakes and volcanoes; changing sea levels; and human activities such as building roads, ports and houses, and damming rivers.

2.10.2 Which coastal landscape features are created by erosion?

Features such as cliffs, headlands, bays, caves and stacks are all landforms found along an eroding coastline (figure 2). These features are formed by wave action and rainfall, which attack the cliffs and find points of weakness that are then eroded. Water running off a cliff face can carry eroded

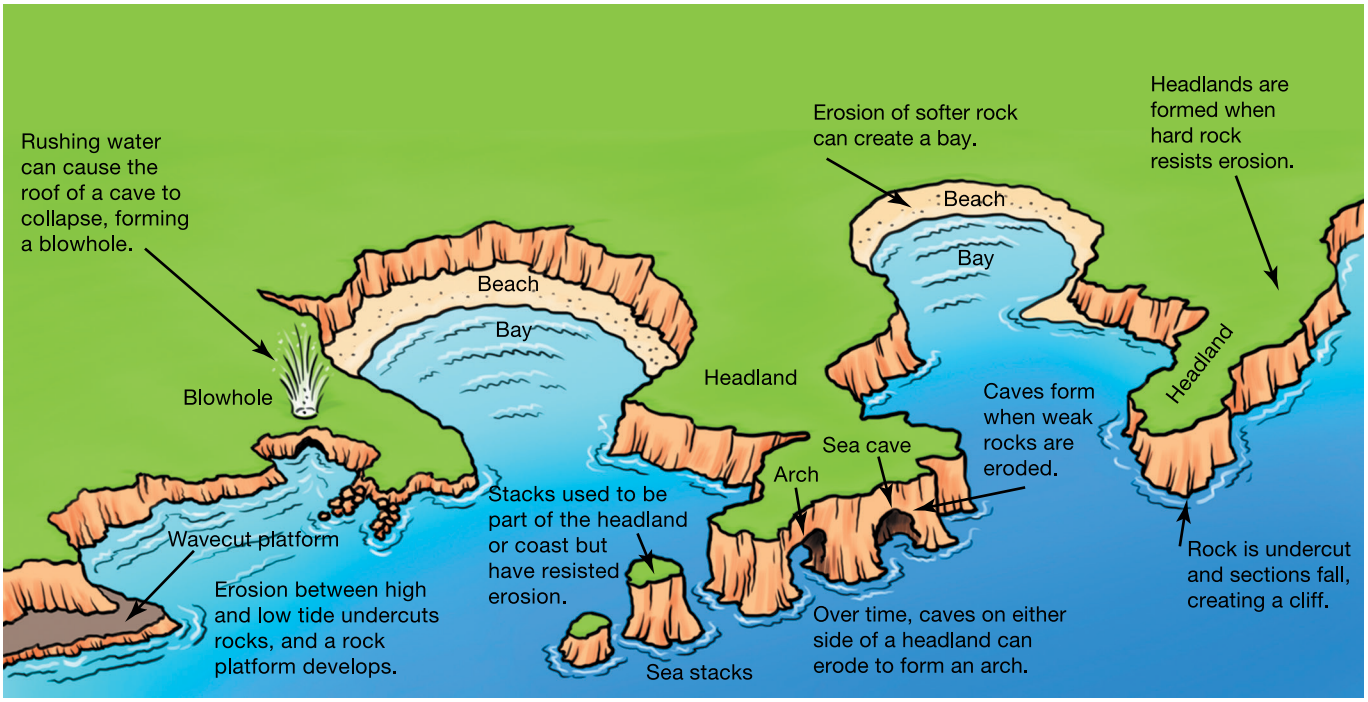
eBook*plus*

Interactivity
Coastal sculpture
Searchlight ID: int-3124

material into the sea below. When waves hit the cliff face, they undercut the base of the cliff to form a notch. As the notch increases in size, the undercut section of the cliff becomes unstable and falls into the sea.

Destructive waves can also alter a sandy coastline. They can remove sand from a beach, destroy the vegetation on dunes, and remove management features designed to protect landscape features.

FIGURE 2 Coastal landforms created by erosion



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Coastal processes

ACTIVITIES

IDENTIFY

1 What are three physical processes that have influenced the creation of coastal landforms.
2 What are three human activities that have influenced the creation of coastal landforms.

EXPLAIN

3 Create an annotated diagram that explains the difference between swash and backwash.
4 Place the following landforms in the order in which they would be created:
  a arch, cave, headland, stack
  b blowhole, cave, cliff.

INVESTIGATE

5 Watch the **Stack formation** weblink and/or the **Cliffed Coast** weblink in the Resources tab. Take note of the process of erosion of a cliff face.
6 In a small group, create your own claymation or stop-motion movie, Prezi, or animated PowerPoint to show the ***changes*** that happen to a cliffed coast eroding to form a notch, cave, arch and stack.
7 Find an image of a sandy coastline that has recently been affected by destructive waves. Explain the process that has occurred. Use the terms *swash* and *backwash* in your explanation.

PREDICT

8 Most Australians live within an hour's drive of the coast, and many people either spend regular holidays on the coast or move to the coast in their retirement, for a 'sea change'. How might the continually ***changing*** coastal landscape (as seen in figure 2) affect coastal

eBook*plus*

Weblinks
Stack formation
Cliffed Coast

housing and popular holiday places? Brainstorm this with a small group.

9 Identify, using a sketch map, how several of the ***changes*** identified in question 8 might affect the coastal landscape of your favourite beach.

10 Do you think people will still feel the same way about a coastal landscape such as the Twelve Apostles when only two or three are still standing? How might the ***changing*** landscape affect the value or pleasure people get from visiting this ***place***? Write a short paragraph to comment.

APPLY

11 Rising sea levels, whether they are a naturally occurring process or have resulted from human activity, will affect coastal landscapes. Use a diagram, with annotations, to explain how rising sea levels could ***change*** two of the landforms illustrated in figure 2.

2.11 How are coastal landscapes shaped by deposition?

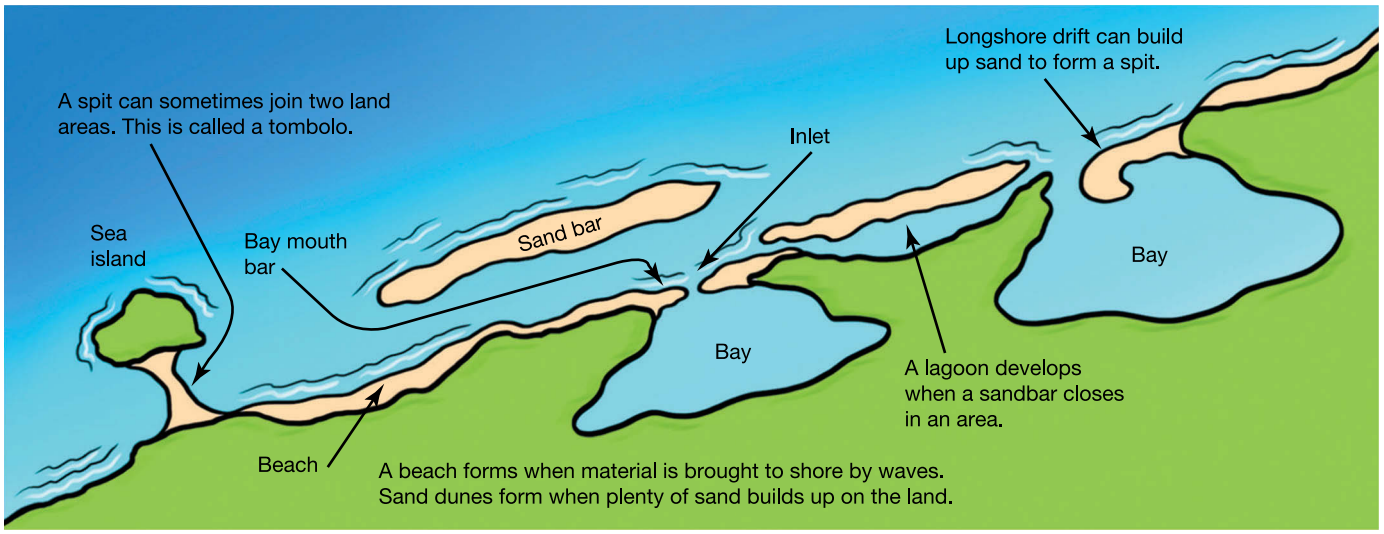
2.11.1 How are depositional coastal landforms formed?

Not all waves are destructive. Some waves gently lap the shoreline. Smaller, gentler waves that carry less energy than destructive waves are known as **constructive waves**. The movement of these waves towards the land is more likely to push material such as sand and shells and deposit them on the beach, building new coastal features.

constructive waves a gentle backwash that leads to material being deposited on land

A beach is a good example of a depositional coastal landform (figure 1). Sand has been deposited and built up over a period of time. Constructive waves build coastal landscape features by repositioning wave-borne materials to also create spits, sand dunes and lagoons.

FIGURE 1 Depositional landforms: coastal landforms created by deposition



The coastal features created by deposition can be created only when material is brought onshore by the swash of constructive waves. The construction material is in the form of sand, shells, coral and pebbles. The source of the construction material may come from eroding cliffs, from an offshore source, or from rivers which, when they enter the sea, dump any material they were transporting.

This construction material is then shaped by prevailing winds. Figure 2 illustrates the cross-section of a beach formed when there is plenty of sand being pushed onshore by the swash. This construction material is dried by the sun and blown inland to create dunes.

FIGURE 2 The formation of sand dunes

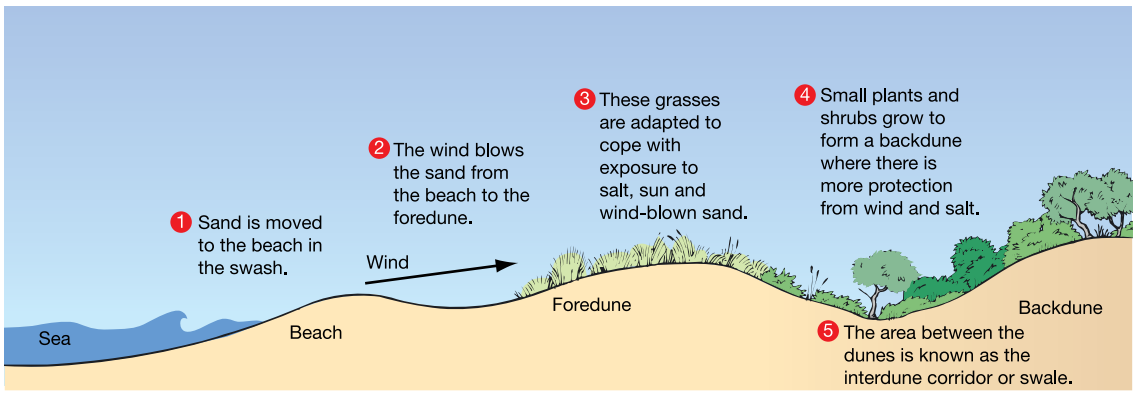


FIGURE 3 The process of longshore drift

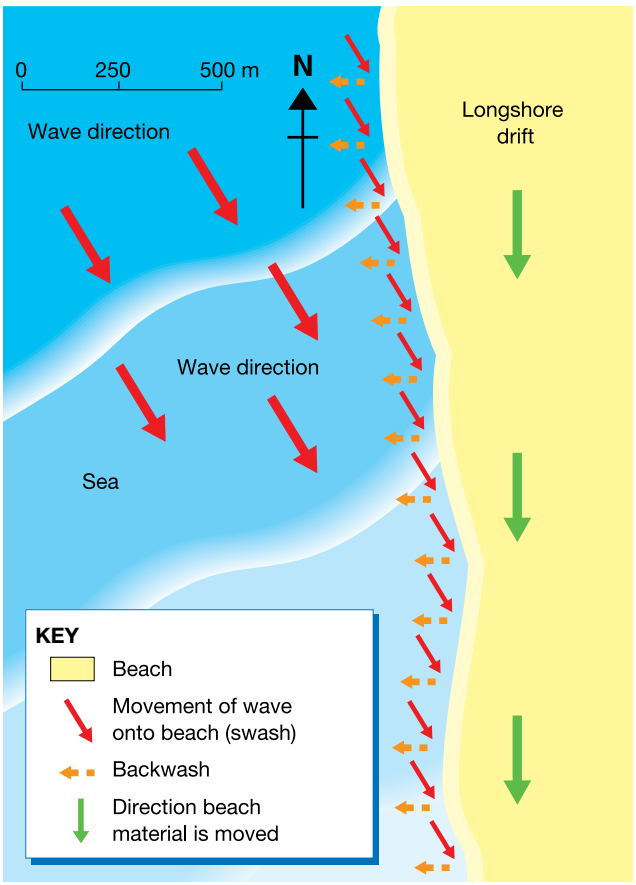


FIGURE 4 The depositional landforms of the coastal landscape at Tutukaka in Northland, New Zealand



Beach material can also be shifted by waves, which get their energy from the wind. The wind influences or directs the angle that waves move towards the coast. Waves come from the direction of the **prevailing wind**. This means that waves often move towards the shore at an angle, and their swash pushes any material they are carrying onto the beach at an angle. As the backwash of the wave returns to the sea, its path takes the shortest possible route down the beach towards the water. This action is known as longshore drift, and it is shown in figure 3. Longshore drift moves material along the beach in a zigzag pattern that follows the direction of the prevailing wind. Longshore drift moves sand along the beach and creates spits and bars. If the prevailing wind changes direction, then so does the direction of longshore drift.

prevailing wind the main direction from which the wind blows

CASE STUDY

The Murray mouth, South Australia

The Murray River is Australia's most important river and the world's sixteenth longest river.

When water for home use and irrigation in the Murray–Darling Basin is not balanced by rainfall, the amount of water that reaches the river mouth decreases. This means that the deposition of longshore drift is stronger than the trickle of water reaching the mouth. In 2009, $24 million was allocated by the Federal government to dredge the mouth of the river in an effort to keep it open.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Coastal processes

ACTIVITIES

EXPLAIN

1 Where does the material come from that builds beaches?

2 Either scan and enlarge a copy of figure 4 or draw a sketch of it, then label or annotate it to identify the depositional landform features of this coastal landscape.

3 The formation of sand dunes cannot happen unless there is plenty of sand in the swash to allow them to grow. Use the information in figure 2 to provide the evidence for you to agree or disagree with this statement.

4 How is weather involved in the formation of sand dune ***environments***?

INVESTIGATE

5 Use your atlas plus the internet to locate and name ***places*** in Australia that have the following coastal landforms: a spit, a beach with dunes, a bay, a headland (point, cape or promontory) and an estuary. Find four examples of each landform and mark them on a map. You could create a Google map of your results, with links to images of each feature.

APPLY

6 **a** In which direction is sand moving on the beach shown in figure 3?

b How will this beach ***change*** if the longshore drift continues in this direction?

c Redraw this diagram to show how the movement of sand along this beach would ***change*** this ***environment*** if the prevailing wind changed to come from the south-west.

7 Referring to figure 2, sketch a new diagram to show what you think would happen to these sand dunes if a fire destroyed the vegetation on the foredune.

8 Describe how coastal landforms are the result of ***interconnections*** between the sea and the atmosphere.

2.13 SkillBuilder: Constructing a field sketch

2.13.1 Tell me

What are field sketches?

Field sketches are drawings completed during fieldwork — geography outside the classroom. Field sketches allow a geographer to capture the main aspects of landscapes in order to edit the view, focusing on the important features and omitting the unnecessary information. Field sketches are free-hand drawings with annotations. Colour may be added but is not a requirement. A field sketch aids our sense of observation and allows us to record and interpret environments. Following a few basic steps, everyone can construct a field sketch!

Why are field sketches useful?

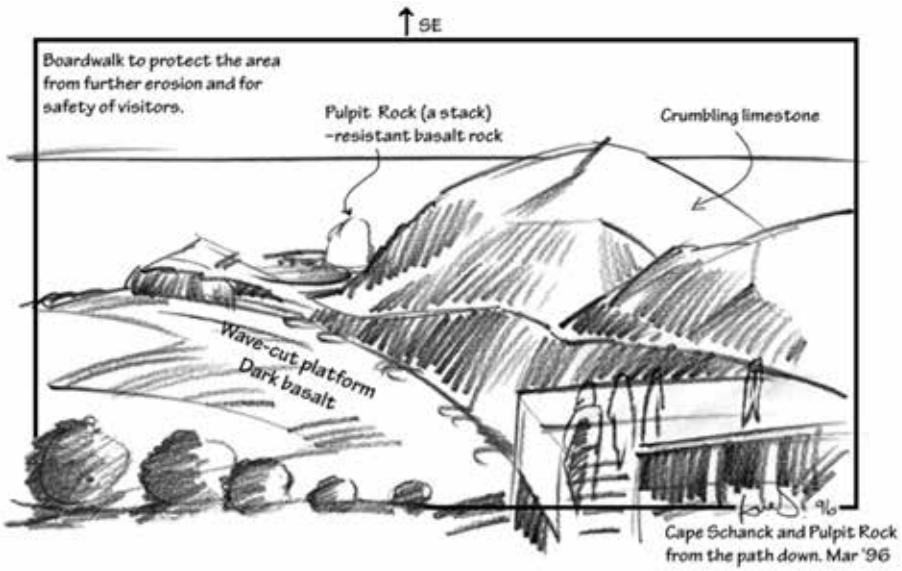
Field sketches capture the important information. You might think it is easier to take an image on your phone or with a camera, but you are then capturing the non-relevant data as well. By making a drawing in the field you are interpreting the environment, analysing the landscape and highlighting a geographical understanding of what you see by careful and clear labelling.

Model

A good field sketch has:

- been completed on plain paper
- been drawn in pencil
- a title
- a date
- labels of key features
- an indicator to show direction
- shading.

FIGURE 1 Field sketch of Cape Schanck



Source: © Geography Teachers' Association of Victoria Inc. Interaction, journal of the GTAV, June 1998. Illustration redrawn by Harry Slaghekke.

2.13.2 Show me

How to complete a field sketch

You will need:

- plain paper
- a clipboard
- a grey pencil (soft)
- a ruler
- an eraser.

Procedure:

Figure 1 is an example of a coastal field sketch. To complete a coastal field sketch you need to be in a coastal environment. Any environment though can be sketched — natural or human-altered. You can choose an environment near you.

STEP 1

Choose the field of view to be sketched; that is, 'from this tree to that bend in the stairs' (as in figure 1). Make yourself comfortable as you'll need to stay in the one place while you complete the sketch.

STEP 2

Partly close your eyes so that you are peeking at the world — all the small details will disappear and your eyes will focus on the main outlines. These main outlines are the first parts drawn. Practise looking at the environment.

eBook*plus*

eLesson
Completing a field sketch
Searchlight ID: eles-1650

STEP 3

Attach your paper securely to the clipboard as wind plays havoc with field sketching. Using a pencil, draw a border (frame) in which you are going to sketch. Always draw in pencil and keep your eraser handy.

STEP 4

Draw in the horizon as a baseline; that is, where the land meets the sky.

STEP 5

Divide your sketch horizontally into three portions: background, middle ground and foreground (the closest to you).

FIGURE 2 Initial outline



Source: © Geography Teachers' Association of Victoria Inc. Interaction, journal of the GTAV, June 1998. Illustration redrawn by Harry Slaghekke.

FIGURE 3 Further detail and shading



Source: © Geography Teachers' Association of Victoria Inc. Interaction, journal of the GTAV, June 1998. Illustration redrawn by Harry Slaghekke.

STEP 6

Peek at the landscape through partly closed eyes and now add the main outlines to your sketch. Start with main features in the background (most distant), then middle ground and lastly foreground. There will be a few shapes on your page, but no detail (see figure 2).

STEP 7

Using this base you can now add details and provide shading to relevant aspects (figure 3). Identify those aspects that are relevant to your study. In this coastal example, there are natural features — a wave-cut platform, a stack, a headland and limestone ridges — and a human feature, the boardwalk.

STEP 8

Annotate (label) your sketch to draw attention to the landscape features. Ask yourself what the connection is between the natural features and the human-altered features. Can your labelling assist in making this interconnection clear to those who view your field sketch?

STEP 9

Finishing touches:

- on the border, add a direction indicator as to which way you are looking at the landscape
- title your sketch — identify the place with as much detail as possible
- date your drawing
- include the direction you are facing (if known).

2.13.3 Let me do it

Developing my skills

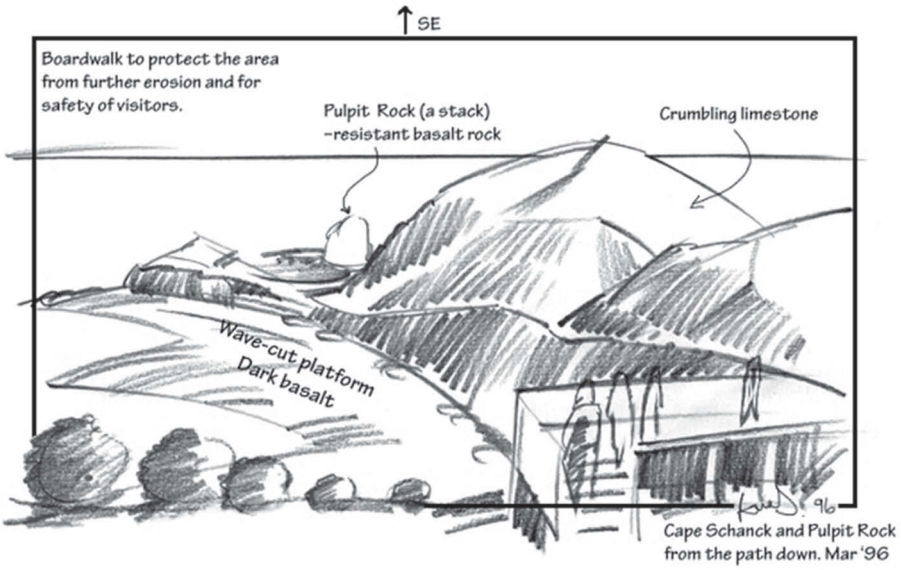
Your teacher may take the class into the school grounds and ask you to do a field sketch of an area within the school boundary, or you may be able to view an environment beyond the fence line.

OR

At home, select a street view or a garden view and complete an annotated field sketch.

Now that you have practised this technique, you are ready to apply this skill to any fieldwork.

FIGURE 4 Completed field sketch with annotations



Source: © Geography Teachers' Association of Victoria Inc. Interaction, journal of the GTAV, June 1998. Illustration redrawn by Harry Slaghekke.

Questions

1. What natural features have been labelled in the field sketch?
2. What human-altered features have been labelled in the field sketch?
3. Is there any interconnectedness between the natural environment and human activities?
4. How do your five senses respond to this environment?
5. How might this place change in the future?

eBook*plus*

Interactivity
Constructing a field sketch
Searchlight ID: int-3146

Checklist

I have:

- drawn a border
- added a compass direction
- titled the sketch
- dated the sketch
- shaded to give depth
- clearly labelled the significant aspects.

Skills questions

1. Field sketching is better than using a camera because:
   a. the picture is clearer
   b. it takes longer to complete
   c. it identifies the key features
   d. it takes time.
2. The purpose of field sketching is to:
   a. show your artistic talent
   b. interpret the environment
   c. save time
   d. be able to go outside.
3. Why is labelling important to a field sketch?
4. What additional value is gained by the use of shading on a field sketch?

2.14 SkillBuilder: How to read a map

2.14.1 Tell me

What are maps and why are they useful?

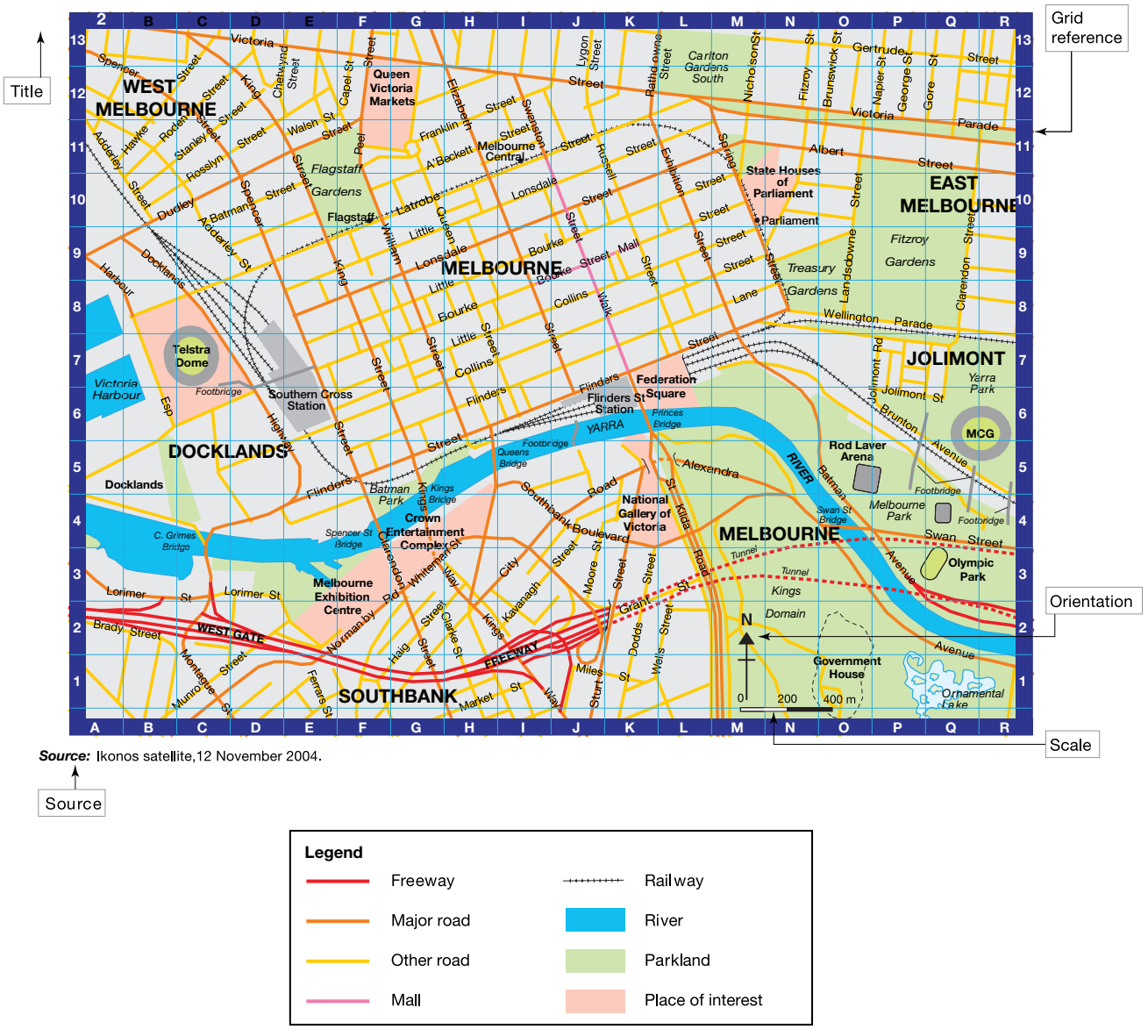
Maps represent parts of the world as if you were looking down from above. The mapmaker or cartographer simplifies the plan view from a vertical aerial photograph or satellite image. Cartographers use colours and symbols on the map to show how features such as roads, rivers and towns are organised in a spatial way. There are six features that should be included on all maps. To help us remember these we use the acronym BOLTSS. Maps are useful to show features so that we have a deeper understanding of places. When travelling, maps are essential to navigate unfamiliar places.

FIGURE 1 Essential map features

BOLTSS

- **B** border — a box around the map to clearly show its extent
- **O** orientation — a compass direction
- **L** legend — a key to what the symbols and colours on the map stand for
- **T** title — a clear indication of what the map is about or its theme
- **S** scale — indicates distances on the map compared with the actual area being shown
- **S** source — where possible, the information used to make the map should be sourced.

FIGURE 2 Melbourne street map



Understanding map legends

When you look at a map you quickly notice the colours and symbols. The legend, or key, lists and explains the colours and symbols used on the map. The legend is usually found next to or in a corner of the map, or it may be located in a special reference section.

Cartographers overcame the difficult task to show all features of an area on a map by using symbols and colour to show point symbols (e.g. church), line symbols (e.g. road) and area symbols (e.g. forest). Many maps use the same symbols to help the reader instantly recognise features; for example, blue lines to represent rivers. These conventional symbols are usually drawn to look like the objects they are representing. The many symbols used in atlases and other maps are small. It is important that you keep your symbols small when making your own maps.

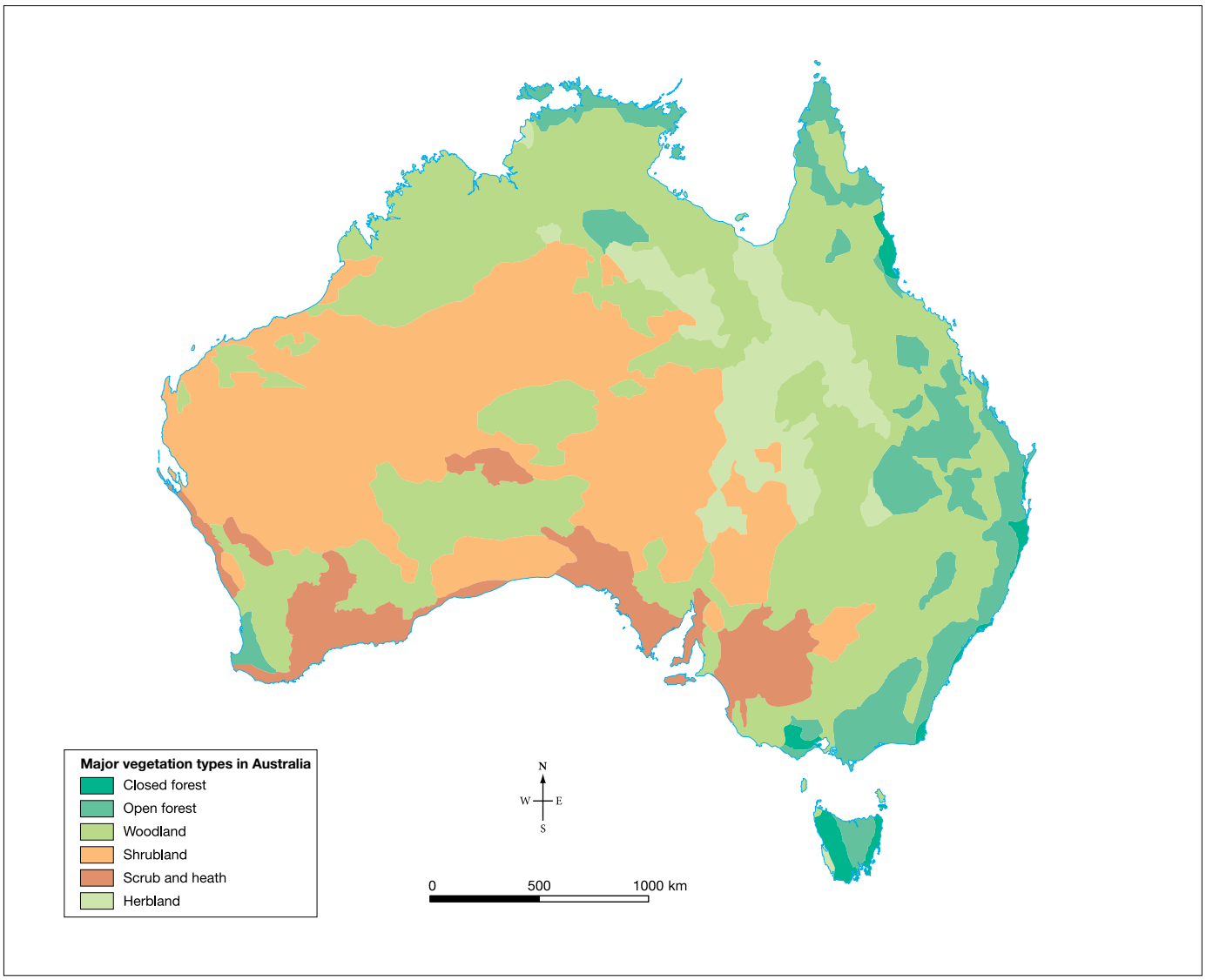
Maps often show features that can be seen from an aeroplane but they also show features that are not visible from the air.

Model

A good map has BOLTSS:

- Border — to show the boundaries of the map
- Orientation — to show direction on the map
- Legend — to explain the symbols and colours used

FIGURE 3 Major vegetation types in Australia



Source: Map taken from http://www.anbg.gov.au/aust-veg/veg-map.html. Reproduced with permission from Sydney University Press

- Title — to describe what the map is
- Scale — to indicate distances on the map
- Source — to explain the source of the information for the map.
  Importantly, the map must be accurate and neat.

eBookplus

eLesson
How to read a map
Searchlight ID: eles-1634

2.14.2 Show me

How to read a map

You will need:

- a map of the region being considered (figure 3).

Procedure:

STEP 1

Identify and carefully read the title of the map because it will provide you with an understanding of the information you can expect to see on the map. Sometimes the title tells you the date of the information that has been mapped. This map has a title that tells us that it is a map of Australia showing major vegetation types. The colours in the key help us to understand the distribution of vegetation.

STEP 2

Next, examine the key. We notice that closed forest is found in about half the area of Tasmania, small linear coastal tracts along parts of the east coast of mainland Australia and in the Otway region of Victoria. We could make a similar detailed description of open forest. Looking at the pattern of forests overall we conclude that only a small area of Australia is forested — less than 10 per cent.

eBookplus

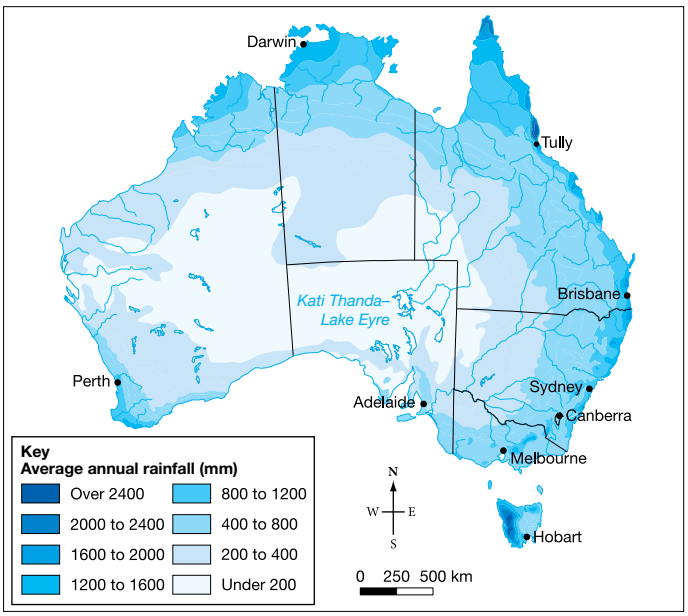
Interactivity
How to read a map
Searchlight ID: int-3130

2.14.3 Let me do it

Developing my skills

Describe the map of Australia's average annual rainfall (figure 4).

FIGURE 4 Average annual rainfall



Source: MAPgraphics Pty Ltd, Brisbane

Questions

1. What is the average annual rainfall of Cairns?
2. What is the average annual rainfall of Australia's state capital cities?
3. Describe the area of Australia that receives less than 300 mm of annual rainfall.
4. Describe the distribution of the wettest areas in Australia.
5. Compare figure 3 and figure 4:
   a. What types of vegetation are found in the area of Australia that receives less than 300 mm of annual rainfall?
   b. What is the relationship between high annual rainfall and closed forest?

Checklist

I have:

- understood the title
- examined all of the parts of the map: key, source, scale, and any annotations and accompanying text
- considered the map as a whole.

Skills questions

1. The person who draws a map is called:
   a. an artist
   b. a knight
   c. an aerial photographer
   d. a cartographer.
2. A map can include information about:
   a. biophysical features such as vegetation
   b. human features such as industrial areas
   c. people's perceptions of places
   d. all of the above.
3. Why do cartographers use blue to represent water including lakes, oceans and rivers?
4. Why might it be important to draw small symbols on a map?

2.16 Review

2.16.1 Review

1. List the nine different types of landscapes.
2. Match the following terms with the correct definition in the table below: deposition, drainage basin, erosion, plateau, tectonic plate, weathering, transportation, sediment.

Term	Definition
	The wearing away and removal of soil and rock by natural elements, such as wind and water, and by human activity
	One of the slow-moving plates that make up the Earth's crust
	The movement of eroded materials to a new location by elements such as wind and water
	The laying down of material carried by rivers, wind, ice and ocean currents or waves
	Material carried by water
	The breaking down of bare rock, mainly by water freezing and cooling as a result of temperature change
	An extensive area of flat land that is higher than the land around it. They are sometimes referred to as tablelands
	An area of land that feeds a river with water; or the whole area of land drained by a river and its tributaries

3. Explain how karst landscapes are formed, and provide an example of a karst landscape.
4. Describe how water flows through catchments. How does this water shape landscapes?
5. Explain how backwash and swash create coastal landscapes.
6. Study the landforms in figure 1 showing the Colorado Plateau, which has been shaped by natural processes over millions of years.
   a. Make a sketch of the landscape and add annotations to explain how the Colorado Plateau is the result of natural processes that have taken place over a long period of time. In your answer, explain how these processes would have sculpted this ***environment***.
   b. Describe how this landscape might have looked in the past and how it might look in the future.
   c. What process do you think is currently dominating the ***changes*** taking place in this landscape? Give reasons for your answer.

FIGURE 1 Part of the Colorado Plateau

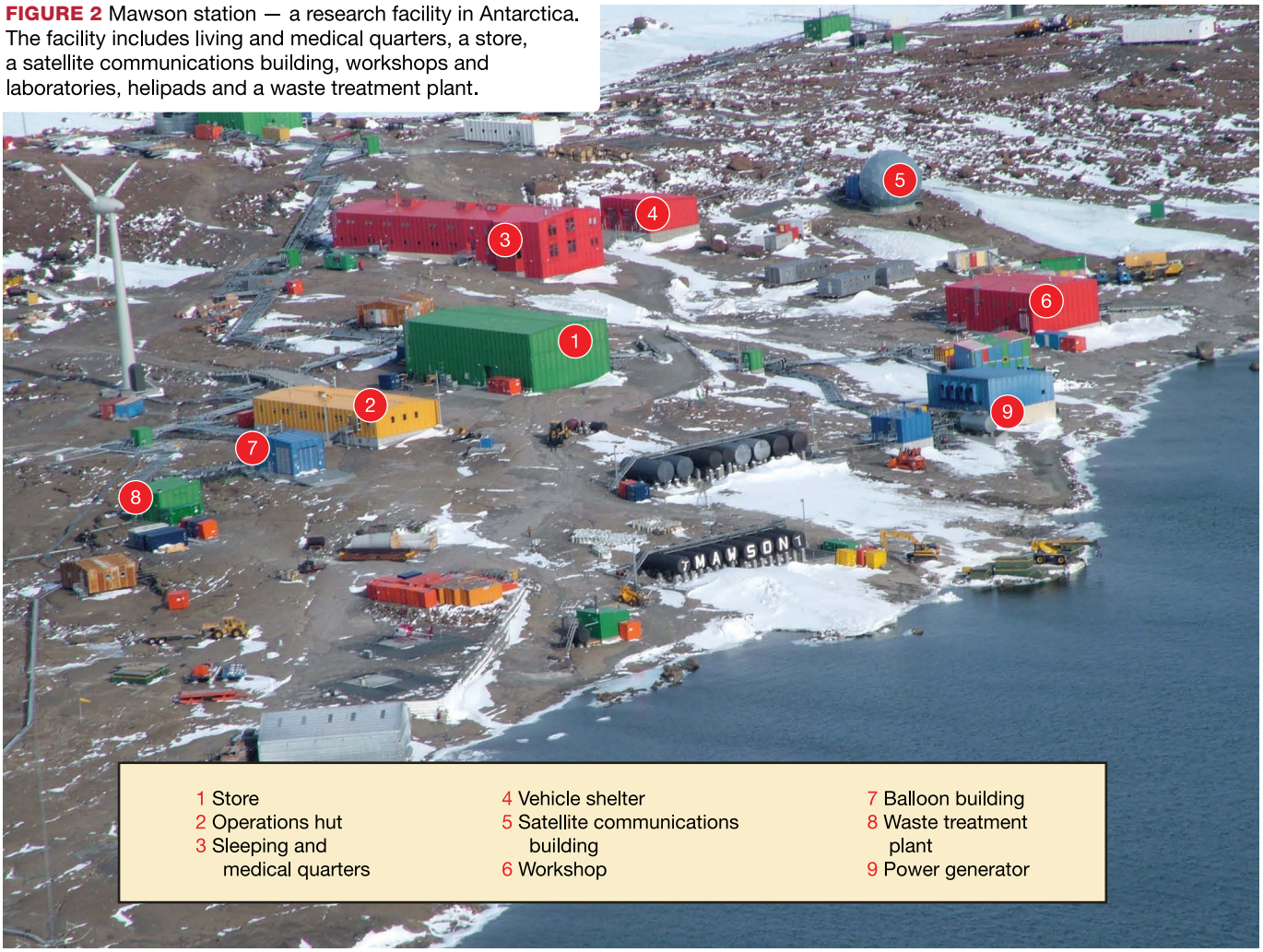


2.16.2 Reflect

Human and physical interactions

7. Use figure 2 to describe what the Antarctic landscape is like.
   a. What problems would be faced by people living and working in this ***environment***?
   b. Do you think people could live and work in this ***environment*** if there were no settlement like the one shown above?
   c. Suggest ways in which people could adapt this settlement to meet their needs.
   d. What impact do you think this human settlement would have (or might potentially have) on this landscape?

FIGURE 2 Mawson station — a research facility in Antarctica. The facility includes living and medical quarters, a store, a satellite communications building, workshops and laboratories, helipads and a waste treatment plant.



8. Explain the title of the following news article.
9. Who are the 'aliens' referred to and how do they travel to Antarctica?
10. Explain the impact these aliens have had on World Heritage-listed Macquarie Island.
11. What does this tell you about the fragile nature of different landscapes?
12. Select another landscape and outline how it could be threatened by alien invaders.

Saving the last frontier

There's an alien invasion under way, and the polar regions are in the frontline.

A key project initiated by the Australian Antarctic Division is Aliens in Antarctica, which is examining the exposure of the South Pole ecosystem to alien species over the past 200 years. Alien organisms include microbes, fungi, grasses, sedges, insects, and feral mammals such as cats and rat.

Each year about 40 000 people go to the Antarctic — scientists, researchers, technicians and tourists. Each of them might unintentionally be carrying alien life in the form of seeds, insects or their eggs, and bacteria in soil particles.

These can be carried in a variety of personal equipment, such as clothing, shoes, day-packs, camera tripods, fresh food and other cargo.

Invasive species can have a dramatic impact on habitat, which, coupled with climate, can have a devastating effect on polar mammals and birdlife.

An example is Macquarie Island, 1500 kilometres south of Australia in the Southern Ocean.

It is home to more than four million birds and is one of the world's most important seabird nesting habitats. It is also a haven for four threatened albatross species, and is the only remaining Australian nesting site of the grey-headed albatross.

$24.6 million was spent in a joint venture to eradicate rats and rabbits on the island and protect its fragile ecology. Since the eradication of feral cats in the 1980s, rabbit numbers exploded from 10 000 to 100 000.

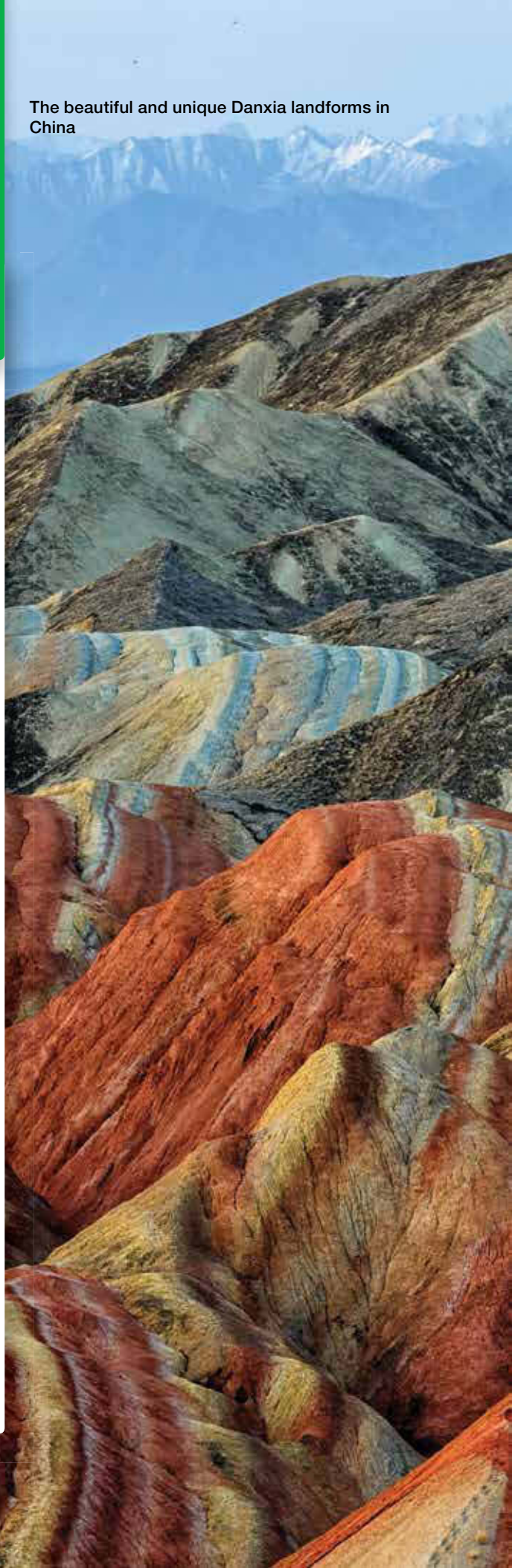
This killed off tussock grasses that were previously bird nesting sites and caused major erosion and large landslips. Twenty landslips were recorded in a single month, killing hundreds of nesting king penguins.

However, teams of rabbit hunters have been going to the island to eradicate the rabbits. Only 13 rabbits were found after the 2011 eradication season, and the island's vegetation is starting to make a strong comeback.

Source: From 'Saving the last frontier' by Vincent Ross/onejourneyman, *The Sunday Mail, Escape* Supplement, 13 July 2008.

CHAPTER 3

Valuing, managing and protecting landscapes and landforms



The beautiful and unique Danxia landforms in China

3.1 Overview

3.1.1 Introduction

There are a variety of reasons why people value landscapes and landforms. They are central to many indigenous cultures' identity, they inspire because of their natural beauty and play a role in the economic activities of humans. Whatever the reason, landscapes and landforms are important to us as humans and we are obliged to manage and protect them sustainably for current and future generations to use and appreciate.

Starter questions

eBookplus
Weblink
Iguazu Falls

1 Use the **Iguazu Falls** weblink in your eBookPLUS to watch a video of the Iguazu Falls.
   a List as many adjectives as you can to describe this landscape.
   b As a class, use an online word cloud generator to create a word cloud using all the adjectives used by your class to describe the landscape. In turn, ask each person to call out their adjectives to be entered into the word cloud generator; include repeated words.
2 Identify and describe two ways in which Iguazu Falls has the potential to make money for the local community.

Inquiry sequence

		Syllabus outcomes
3.1 Overview		
3.2 Why do people value landscapes and landforms?		GE4-4
3.3 How do landscapes and landforms have cultural and spiritual value?		GE4-4
3.4 What are the economic values of landscapes and landforms?		GE4-4
3.5 SkillBuilder: Using positional language	eBookplus ONLINE ONLY	GE4-3, GE4-7
3.6 How are landscapes protected and managed?		GE4-5
3.7 Kakadu—Australia's first World Heritage Area	eBookplus ONLINE ONLY	GE4-4, GE4-5
3.8 Why is Uluru an iconic Australian landform?		GE4-4, GE4-5
3.9 How is Uluru protected and managed?		GE4-5
3.10 How have humans changed and degraded landscapes?		GE4-2
3.11 What are geomorphic hazards?		GE4-2
3.12 SkillBuilder: Using topographic maps	eBookplus ONLINE ONLY	GE4-3, GE4-7
3.13 Investigating topographic maps: What is the value of Gunnedah Shire?		
3.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Landscapes sculpted by water
Searchlight ID: eles-1624

3.2 Why do people value landscapes and landforms?

3.2.1 What are the aesthetic values of landscapes and landforms?

Landscapes and landforms are valuable as they play an important part in the way the physical environment functions. However, humans have always been interconnected with landscapes and believe they are important for their aesthetic, economic, cultural and spiritual values.

aesthetic relating to something beautiful and pleasing to look at

Many landscapes and landforms are valuable to humans because of their natural beauty. This is also known as **aesthetic** value. There is a variety of landscapes that inspire people, from the vibrant and colourful coral reef aquatic ecosystems to the beautiful vista of a mountain landscape. Many recreational activities are taken up because of the aesthetic value of landscapes and landforms (figure 1). People participate in outdoor recreations such as scuba diving, bushwalking, rock sports and photography. Artists, poets and musicians have also been inspired by the aesthetics of landscapes, and have created some of the most famous pieces of poetry, art and songs about them (see case study below).



FIGURE 1 Outdoor recreational activities take advantage of the natural beauty of landscapes and landforms.



FIGURE 2 The beach and lifesavers are recognised as part of Australia's cultural identity.

3.2.2 The beach — Australian cultural identity

The aesthetic value of the beach landform plays an important part in Australia's national identity. Globally, Australia is well known for its beautiful beaches and its leisure lifestyle based around the beach (figure 2). Many international tourists will visit one or more of Australia's famous beaches such as Bondi Beach in Sydney, Broadbeach on the Gold Coast or Bells Beach in Victoria. This is due to Australia being a large island continent with 10 685 beaches, and most of its population living within 50 kilometres of the coastline, making access to the beach relatively easy.

CASE STUDY

'My Country'

Dorothea Mackellar was an Australian poet who wrote 'My Country', one of the most famous poems about the Australian landscape. She grew up in the city, but her family had property in the Hunter Valley of New South Wales, and near Gunnedah to the north. She visited these places frequently and was heavily influenced by the landscapes she saw.

I love a sunburnt country,
A land of sweeping plains,
Of ragged mountain ranges,
Of droughts and flooding rains.
I love her far horizons,
I love her jewel-sea,
Her beauty and her terror –
The wide brown land for me!

FOCUS ON FIELDWORK

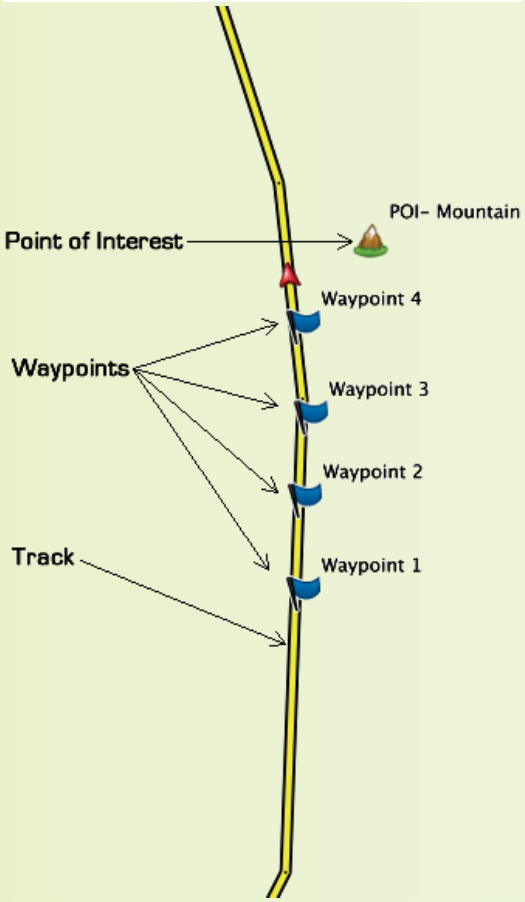
Using a GPS in the field

A popular instrument that bushwalkers use, which is a valuable fieldwork tool for Geographers, is a hand-held Global Positioning System (GPS) device. These can be a specialty device or an application on a smartphone (figure 3). A GPS accurately locates a person on the surface of the Earth by connecting to **geostationary satellites** that are in orbit around our planet. GPS devices record locations by logging in your latitude and longitude at a particular spot. These are called **Waypoints**. If you walk along a path, a GPS unit can record your **Track**. Another feature on a GPS is that a person can log in **Points of Interest** (POI) to help locate places they have found interesting and want to visit again. All this data can be transferred to mapping software such as GIS or Google Earth so it can be accurately viewed on a map (figure 4). Also, the GPS can be used to navigate back to Waypoints and POIs and/or to follow a track that has been recorded (a route).

FIGURE 3 A smartphone with a GPS application installed



FIGURE 4 Waypoints, Tracks, Routes and POI as recorded by a GPS and put on a map



geostationary satellites satellites that orbit with the Earth's rotation and appear to be stationary in the sky making locating features on the Earth's surface more accurate with GPS

ACTIVITIES

IDENTIFY

1 Define the word *aesthetic*.

2 Name and describe some recreational activities you can do in landscapes.

EXPLAIN

3 Explain why the beach is considered part of Australia's cultural identity.

INVESTIGATE

4 There have been numerous songs and artists that have been inspired by landscapes. Research either a song or an artwork that is well known. Outline how the artist or songwriter described or portrayed the beauty of the landscape.

APPLY

5 Think of a landscape or landform you have visited. Write a poem or a song using as many adjectives as you can to describe what the landscape/landform looks like and how it made you feel.

6 a Conduct a survey in your class to count how many people visit the beach. Create a table that will tally your results like this:

Visit beach daily	Visit beach weekly	Visit beach monthly	Visit beach yearly	Rarely or never

b Based on your class results, do you think the beach is an important part of your culture? What are the location reasons that would explain your results?

3.3 How do landscapes and landforms have cultural and spiritual value?

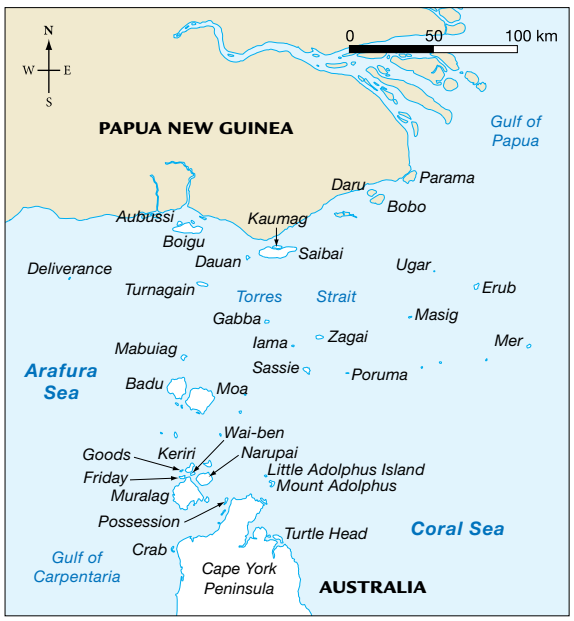
Dreaming in Aboriginal culture, the time when the Earth took on its present form, and cycles of life and nature began, also known as the Dreamtime. Dreaming Stories pass on important knowledge laws and beliefs.

3.3.1 The Australian experience

Humans have always been interconnected with the physical environment, and landscapes and landforms have helped shape our beliefs and way of life. Many of the world's indigenous people continue to have a special relationship with their physical surroundings, and these landscapes continue to be an important part of their culture and spirituality.

Australian Aboriginal and Torres Strait Islander people inhabited Australia for thousands of years before European settlement. Their culture and spirituality are linked to the landscapes that they live in. Both the Aboriginal and Torres Strait Islander people recount how their ancestors created the landforms as they travelled across the landscape during a time that is commonly referred to as The **Dreaming**.

FIGURE 1 Location map of Torres Strait islands



Source: Geoscience Australia

The Dreaming and Tagai

The Dreaming has different meanings to the various Indigenous peoples around Australia. Generally, Dreaming Stories tell of a time when the Aboriginal ancestors travelled across the country and created the variety of landscapes, landforms, plants and animals by either carving them out or becoming the landforms themselves (see case study below). This makes all elements of the physical environment related to Aboriginal people. All aspects of Aboriginal culture from art, dance and stories are centred around The Dreaming, and the landscapes and landforms are their sacred spaces.

The Torres Strait Islander people are the Indigenous people living on the tip of Cape York and the 17 islands in the Torres Strait between Australia and Papua New Guinea (figure 1). They are culturally different to mainland Aboriginal people and their stories are set around the Tagai, a warrior who is visible in the stars. These helped them navigate the islands in their canoes and explain the close connection with the landscapes and oceans around them. Both Aboriginal and Torres Strait Islander people are dependent on their surroundings, and the landscapes and landforms are crucial to their culture and spirituality.

CASE STUDY

Ngiyaampaa Dreaming

The following Dreaming Story is told by Aunty Beryl Carmichael, from the Ngiyaampaa people of western New South Wales. It tells the story of Ngiyaampaa country and how the Darling River was created (figure 2).

Now long, long time ago of course, in the beginning, when there was no people, no trees, no plants whatever on this land, 'Guthi-guthi', the spirit of our ancestral being, he lived up in the sky. So he came down and he wanted to create the special land for people and animals and birds to live in. So Guthi-guthi came down and he went on creating the land for the people — after he'd set the borders in place and the sacred sites, the birthing places of all the Dreamings, where all our Dreamings were to come out of.

Guthi-guthi put one foot on Gunderbooka Mountain and another one at Mt Grenfell. And he looked out over the land and he could see that the land was bare. There was no water in sight, there was nothing growing. So Guthi-guthi knew that trapped in a mountain — Mt Minara — the water serpent, Weowie, he was trapped in the mountain. So Guthi-guthi called out to him, 'Weowie, Weowie', but because Weowie was trapped right in the middle of the mountain, he

couldn't hear him. Guthi-guthi went back up into the sky and he called out once more, 'Weowie', but once again Weowie didn't respond. So Guthi-guthi came down with a roar like thunder and banged on the mountain and the mountain split open. Weowie the water serpent came out. And where the water serpent travelled he made waterholes and streams and depressions in the land. So once all that was finished, of course, Weowie went back into the mountain to live and that's where Weowie lives now, in Mount Minara. Old Pundu, the cod, it was his duty to drag and create the river known as the Darling River today. So what I'm telling you — the stories that were handed down to me — all come from within this country.

FIGURE 2 The meandering landscape of the Darling River in Menindee, NSW, where Ngiyaampaa people tell of Weowie the water serpent who travelled and made the water holes and depressions.



ACTIVITIES

IDENTIFY

1 What is The Dreaming?
2 Describe where the Torres Strait Islander people are located.

EXPLAIN

3 Read the Dreaming Story as told by Aunty Beryl Carmichael. What landscapes and landforms are being created?
4 Why do Aboriginal and Torres Strait Islander people believe they are related to the land?
5 What is a sacred site?
6 Explain why landforms and landscapes are an important place to Aboriginal and Torres Strait Islander people.

INVESTIGATE

7 Research and identify the name/s of your local Aboriginal nation.
8 Research a local Aboriginal sacred site in your area or region. Describe its landscape or landforms. Locate the site using an online mapping engine such as Google Maps, Bing Maps or OpenStreetMap.
9 Organise with your class for an Aboriginal elder from your local area to share a Dreaming Story that you are allowed to hear that describes the creation of a local landscape or landform.

3.4 What are the economic values of landscapes and landforms?

3.4.1 Tourism

'Economic' is a word we use to describe how we, as humans, make money and spend money. Humans have used landscapes and landforms to dig out natural resources, but they can also be a valuable source of money in their natural state. As outlined in 3.1, landscapes and landforms hold aesthetic values and people are willing to spend money to enjoy them.

Tourism is when people travel to other places from where they live for recreation, pleasure, relaxation or education. Many landscapes and landforms are excellent tourist destinations and are important for local communities because of the money and jobs created for the local economy. For example, the Great Barrier Reef is the largest coral reef landform in the world and tourism was responsible for 91 per cent of the economic activity in the region. In 2012 over $6.4 billion was spent by tourists and tourism was responsible for creating over 64 000 full-time jobs.

Adventure tourism

A type of tourism that attracts people to landscapes and landforms is adventure tourism. This is a trip that has at least two of the following:

- a physical activity
- occurs in the natural environment
- cultural immersion.

Many landscapes and landforms are a great place for people to enjoy adventure tourism by participating in activities such as rock climbing, mountain biking and hiking (figure 1). Adventure tourism activities are classified as 'soft' as most people can participate and 'hard' where significant skills and equipment are needed (see table 1). Economically, adventure tourism makes money at a local scale by directly benefiting local communities through the money spent on accommodation, eating out or guides. Adventure tourism often requires specialised equipment, such as skis, bikes or ropes, so, at a larger scale, it contributes to the national and global economy. For example, the hard adventure activity of climbing the landform of Mount Everest, the world's highest mountain, cost on average US$48 000 per person. The permit to climb is US$11 000 and there is the additional cost of buying training, specialised equipment, airfare and tour guides.



FIGURE 1 Mountain biking is a popular form of adventure tourism that enjoys the aesthetics of landscapes and landforms and helps local economies.

TABLE 1 Types of adventure tourism activities

Activity	Category Hard: significant skill and effort Soft: some skill and effort
Backpacking	Soft
Bird watching	Soft
Camping	Soft
Canoeing	Soft
Caving	Hard
Climbing (mountain/rock/ice)	Hard
Hiking	Soft
Horse riding	Soft
Hunting	Soft
Kayaking/sea/whitewater	Hard
Mountain biking	Hard
Safaris	Soft
Scuba diving	Soft
Skiing/snowboarding	Soft
Surfing	Soft
Trekking	Soft
Walking tours	Soft

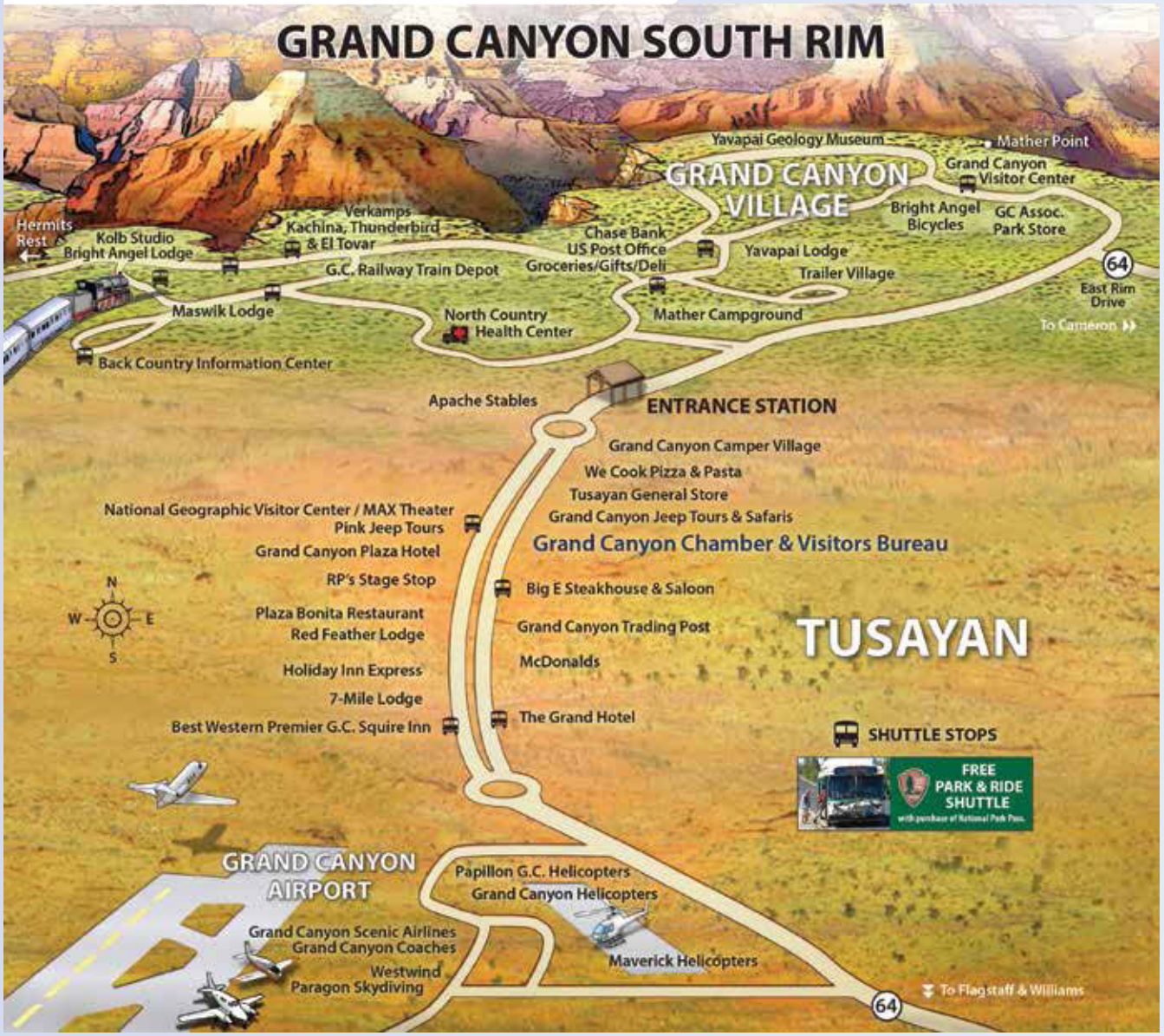
Source: World Tourism Organization (2014), AM Reports, Volume nine — Global Report on Adventure Tourism, UNWTO, Madrid.

CASE STUDY

Grand Canyon National Park, United States

The Grand Canyon is a famous, steep-sided canyon in the Unites States that was created by the processes of weathering and erosion caused by the Colorado River. It is a distinctive landform that is 446 kilometres long and in some parts 18 kilometres wide. This landform has a large economic impact on the local communities. In 2011, $4.7 billion was spent by the 4.3 million visitors to the Grand Canyon National Park. Over 7361 jobs were created either directly or indirectly because of the tourist trade (figure 2).

FIGURE 2 Pictorial map showing tourist activities in the Grand Canyon



pictorial map a map using illustrations to represent information

Most park visitor spending within the park is for accommodation, followed by food and beverages, fuel, admissions and fees, and souvenirs. Local communities up to 100 kilometres away also benefit from tourist spending as tourists travel to the Grand Canyon National Park and purchase food and other provisions. Apart from guided tours, visitors participate in a variety of activities including hiking and walking tours, river rafting, helicopter tours and tandem skydiving which provides employment opportunities for local people.

ACTIVITIES

IDENTIFY

1 What is tourism?

2 Using statistics in the text and case study, copy and complete a table like the one below that compares the economic benefits of tourism in the Great Barrier Reef and the Grand Canyon.

	The Great Barrier Reef	The Grand Canyon
Continent and country		
Visitors		
Money spent by visitors		
Jobs created		
Activities		

EXPLAIN

3 Explain why adventure tourism relies on landscapes and landforms.

4 How does adventure tourism make money directly and indirectly for the economy?

INVESTIGATE

5 Using an atlas and the internet, locate and name some popular places around the world where the following activities can be conducted.
- a Scuba diving
- b Rock climbing
- c Mountain photography
- d Aboriginal rock art tour

APPLY

6 a Locate Kings Canyon in the Northern Territory on a map.
- b Create a list of what you would need to purchase and the services you would need to pay for if you were to go on an adventure in Kings Canyon in the Northern Territory.
- c List some activities you could do in this landscape.

7 Refer to figure 2. List as many activities as you can that provide jobs and places where tourists can spend money.

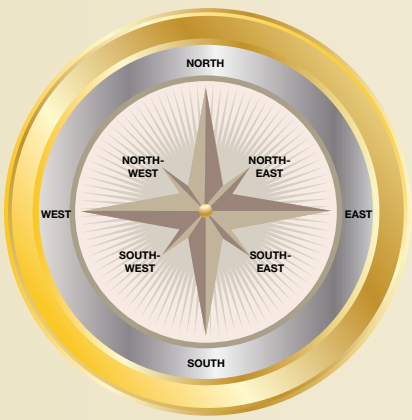
myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
- Grand Canyon
- Himalayas video

eBookplus ONLINE ONLY

3.5 SkillBuilder: Using positional language

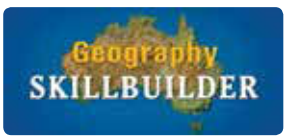
What is positional language?

Positional language is the use of compass points to locate places and provide directions between places. North, north-east, east, south-east, south, south-west, west, and north-west are shown on an 8-point compass. We can use positional language to describe the location of one feature in relation to another.



eLesson

Watch this video to learn how to use positional language.



Searchlight ID: eles-1649

Interactivity

Try this interactivity to learn how to use positional language.



Searchlight ID: int-3145

3.6 How are landscapes protected and managed?

3.6.1 The World Heritage Convention

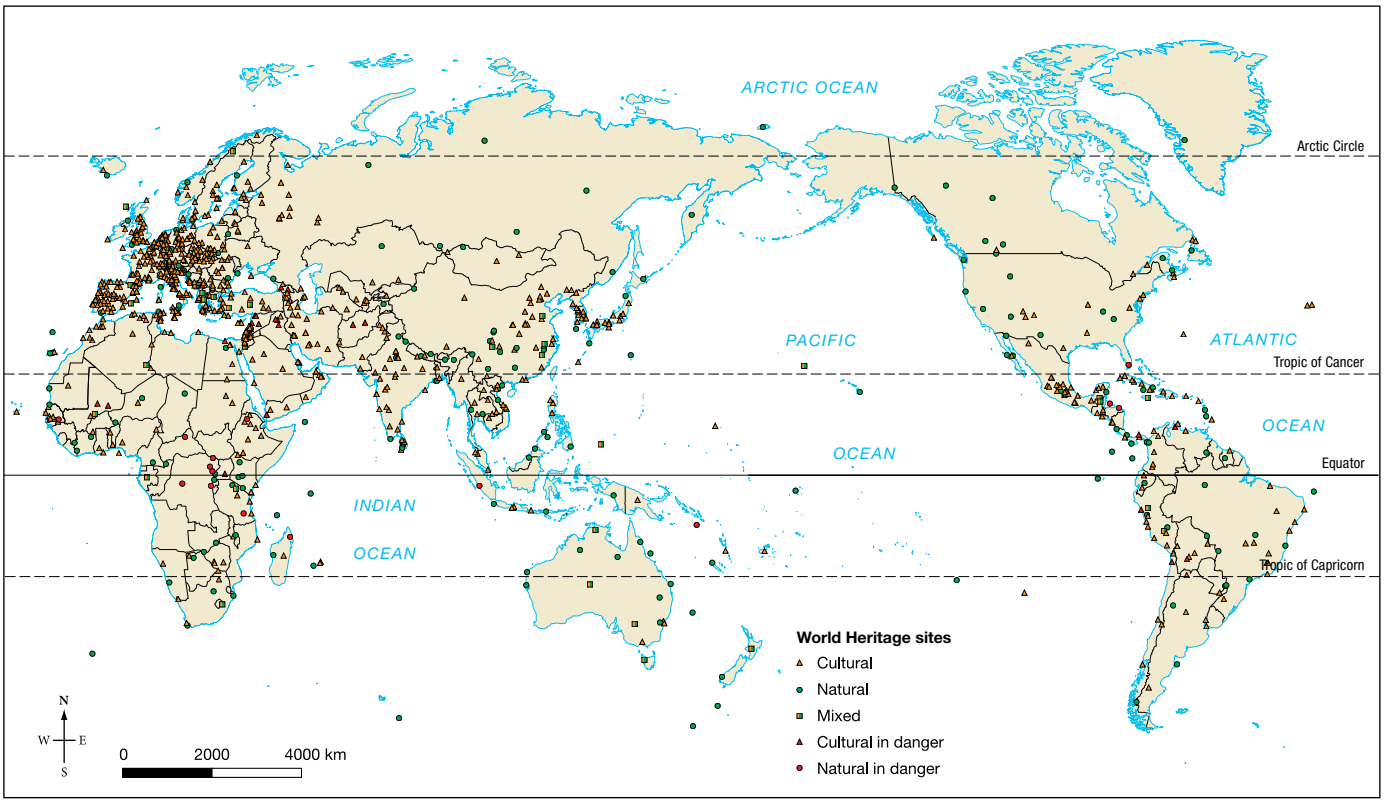
People have realised the value of landscapes and landforms, and the need to protect and manage them more effectively. This is so that they can ensure the landscapes and landforms continue to function in their natural state, as they are habitats for a variety of plants and animals, and so that future generations are able to enjoy them too. There are international agreements in place at the global scale to help protect these places and, at a local scale, governments have created areas that can be managed and protected by special laws that ensure the **sustainable** use of landscapes and landforms.

The World Heritage Convention is an international agreement that has been signed by 190 countries since 1972. This was recognition at a global scale that there are important parts of the physical and human environments that needed to be protected. The convention is overseen by UNESCO (United Nations Educational, Scientific and Cultural Organization). The process begins by a country nominating a place inside its territories as a World Heritage site, then the World Heritage Committee assess if it matches at least one of the 10 set criteria (see table 1). If it adequately addresses the criteria, it is inscribed on to the **World Heritage List** and it will be become a World Heritage site (figure 1). It is expected that the country the site is located in will take all precaution to protect and manage it. In some countries, once a place is put on the World Heritage List, their national and local laws protect it.

sustainable to use the environment now in such a way that it continues to support our lives and the lives of other living creatures into the future

World Heritage List a list of human and natural sites that have been approved by UNESCO as meeting the criteria of being a World Heritage site

FIGURE 1 The World Heritage List includes 1031 sites of significance.



Source: Copyright © 1992 - 2016 UNESCO/World Heritage Centre. All rights reserved

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › World Heritage sites

TABLE 1 The UNESCO Criteria for World Heritage sites

The 10 criteria for the selection of outstanding and/or unique World Heritage sites are summarised below. They should show:

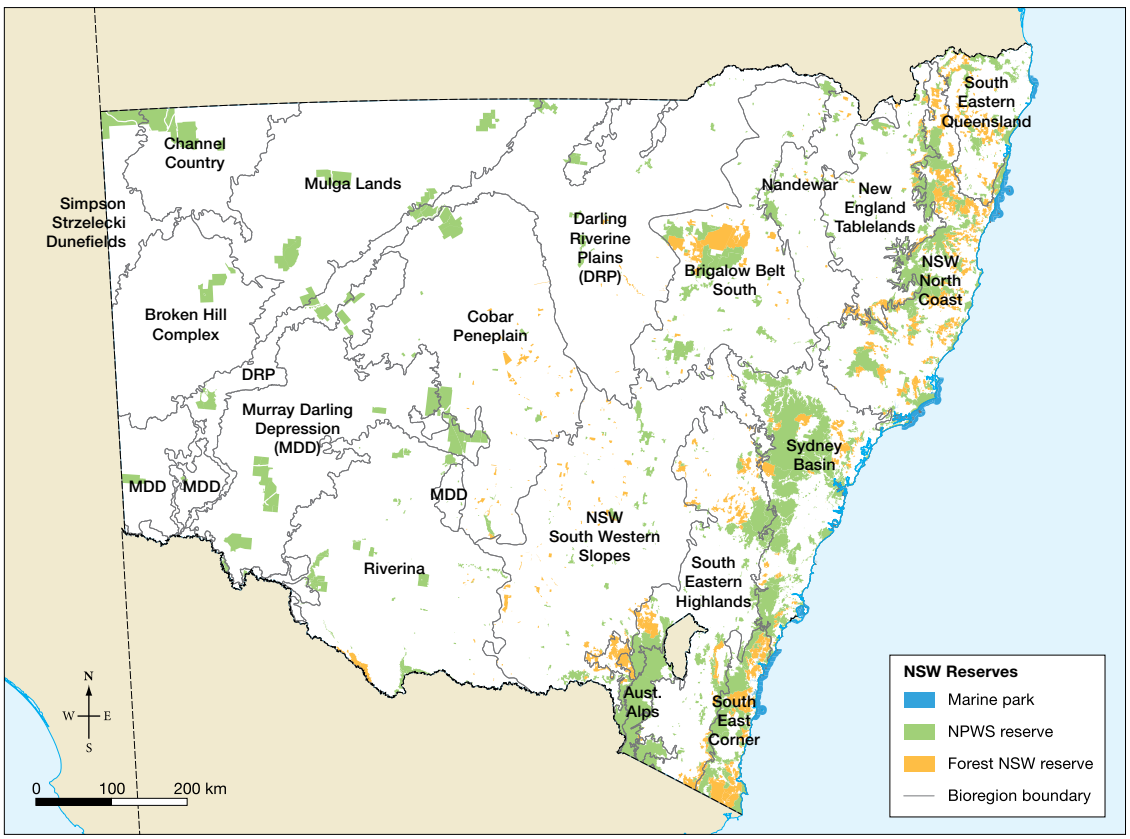
Cultural sites
i. human creative genius
ii. exchange of human values, over time or within a culture
iii. culture or civilisation that is living or has disappeared
iv. building or landscape that illustrates significant stage(s) in human history
v. human settlement representing human interaction with the environment, especially if vulnerable to extinction
vi. events, traditions, ideas or beliefs
Natural sites
vii. exceptional natural beauty and importance
viii. major stages of the earth's natural processes such as landforms
ix. ongoing processes in the evolution of living things and developing ecosystems
x. important natural habitats for conservation of biodiversity

Source: UNESCO

National parks and reserves

At a national and state level, governments have created special places called national parks and reserves. These are places that are protected by law and have special rules on how they can be accessed and used. In NSW, Australia, the National Parks and Wildlife Service (NPWS) manages 850 national parks and reserves that cover over 7 million hectares of land (figure 2). This includes four World Heritage sites, a number of Australian National Heritage sites and 17 Ramsar wetlands (these are wetlands that have been ratified by the International Convention on Wetlands). There are different types of parks with different purposes that are managed by National Parks and Wildlife. These range from areas that are completely protected, with minimum human interference, to areas that allow many human activities. As each different landscape requires different levels of management, each national park has its own managers and strategies that best suit its needs.

FIGURE 2 Location of the 850 national parks and reserves in NSW, Australia



Source: Commonwealth Dept. of Environment, CAPAD 2014 (terrestrial and marine), IBRA7, NSW Forestry Corporation

FOCUS ON FIELDWORK

Using a compass

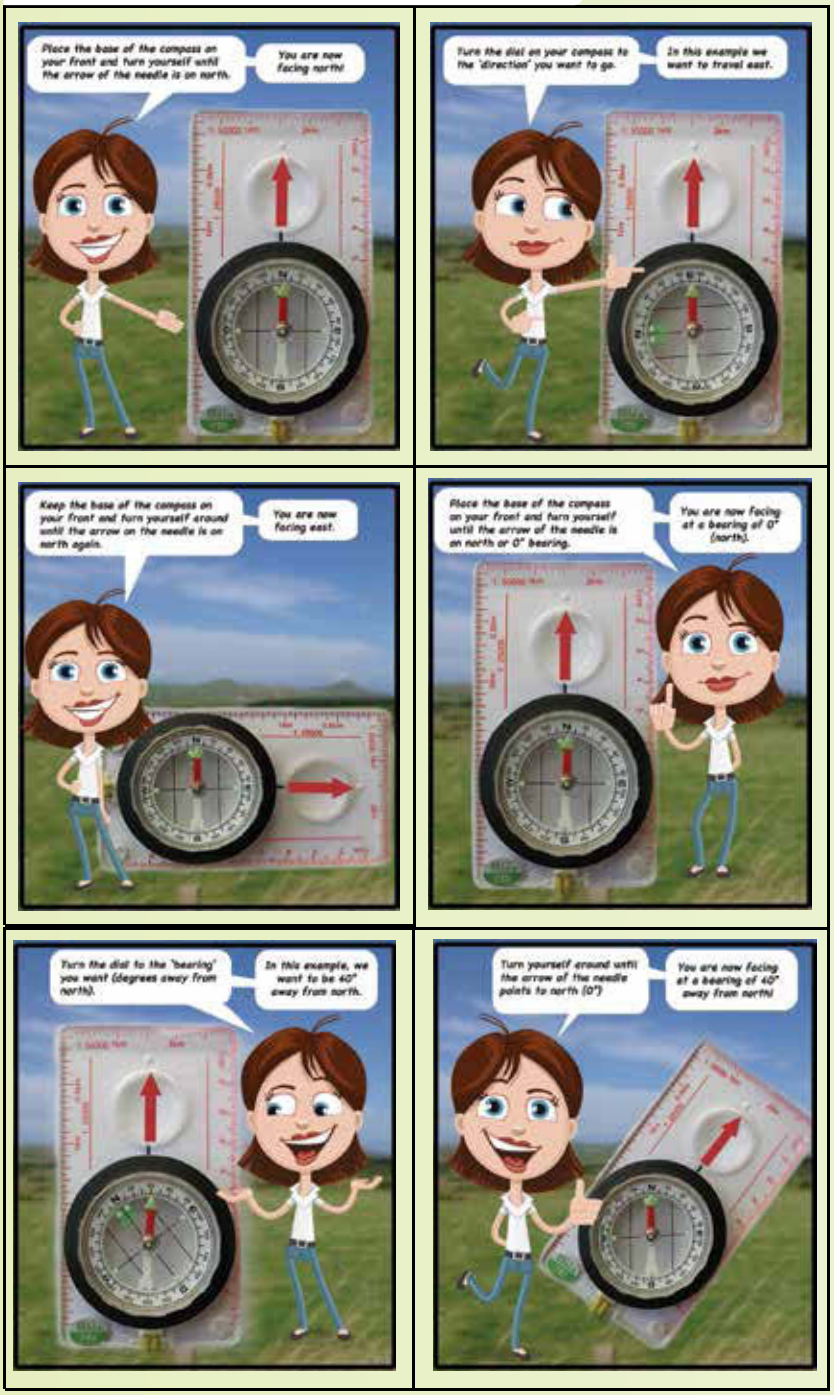
1 Use a compass to complete the following activities:
   - **a** In what direction is the whiteboard from where you are sitting in the classroom?
   - **b** In what direction is the canteen from your geography classroom?
   - **c** In what direction is your home from the school?
   - **d** Name four suburbs or towns that surround your school. In what direction are they from your school?

2 Write down the directions you would give for someone to navigate, using the cardinal and ordinal points of a compass, from the front gate of your school to your geography classroom.

3 Write down the directions you would give for someone to navigate, using bearings, from the front gate of your school to your geography classroom.

4 Which method of giving directions with a compass is more accurate?

FIGURE 3 Using a compass — direction and bearing



ACTIVITIES

IDENTIFY

1 Why have people realised that landscapes and landforms need be protected and managed?

2 Give an example of a global ***scale*** strategy and an example of local ***scale*** strategy to protect and manage landscapes and landforms.

EXPLAIN

3 Create a flow diagram that shows how a site becomes a World Heritage Area.

4 Why do the different national parks and reserves have their own managers and management strategies?

INVESTIGATE

5 Using the internet, research NSW national parks. Create a table with the column headings shown and research the different types of parks within the National Parks and Wildlife Service of NSW.

Type of park	Description	Examples	Example nearest to my home

6 Research a landscape or landform that is on the World Heritage List and write an explanation of what criteria were used to put it on the list.

APPLY

7 Choose a landscape or landform that is not on the World Heritage List and that you think should be included. Prepare a proposal to the World Heritage Committee, either through a report, slide presentation or multimedia presentation, trying to persuade them, by using the appropriate criteria, to place your chosen site on the World Heritage List.

inselberg an isolated hill, knob, ridge, outcrop or small mountain that rises abruptly from the surrounding landscape

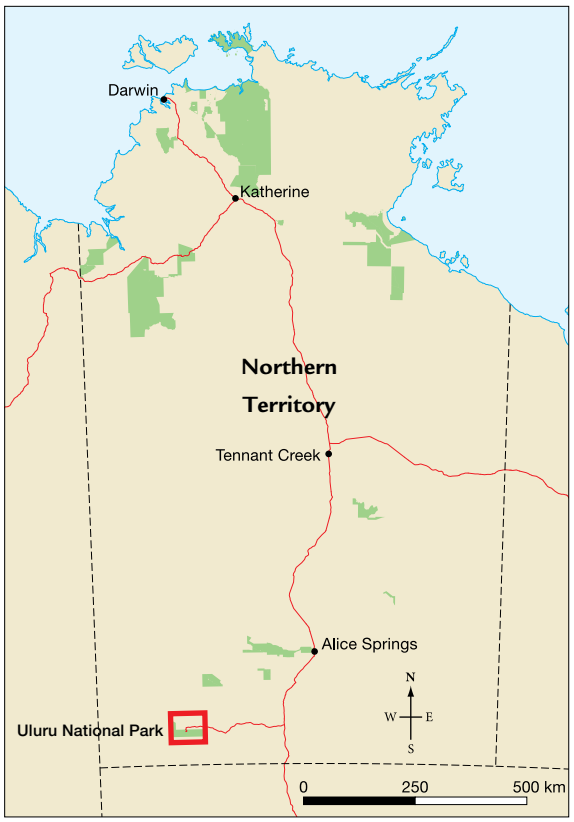
plateau an extensive area of flat land that is higher than the land around it. Plateaus are sometimes referred to as tablelands.

eBook*plus* ONLINE ONLY

3.7 Kakadu – Australia's first World Heritage Area

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au.**

FIGURE 1 Location of Uluru



Source: Spatial Vision

3.8 Why is Uluru an iconic Australian landform?

3.8.1 Aesthetic value

Uluru is one of Australia's most famous and recognisable landforms. It is located very close to the centre of Australia in the south-west corner of the Northern Territory (figure 1). It is a large sandstone **inselberg**, a word that literally means 'island mountain'. It is 3.6 kilometres long, 1.9 kilometres wide and 348 metres high from ground level but it is 860 metres above the sea level as it is located on a **plateau**. Its perimeter measures roughly 9.4 kilometres.

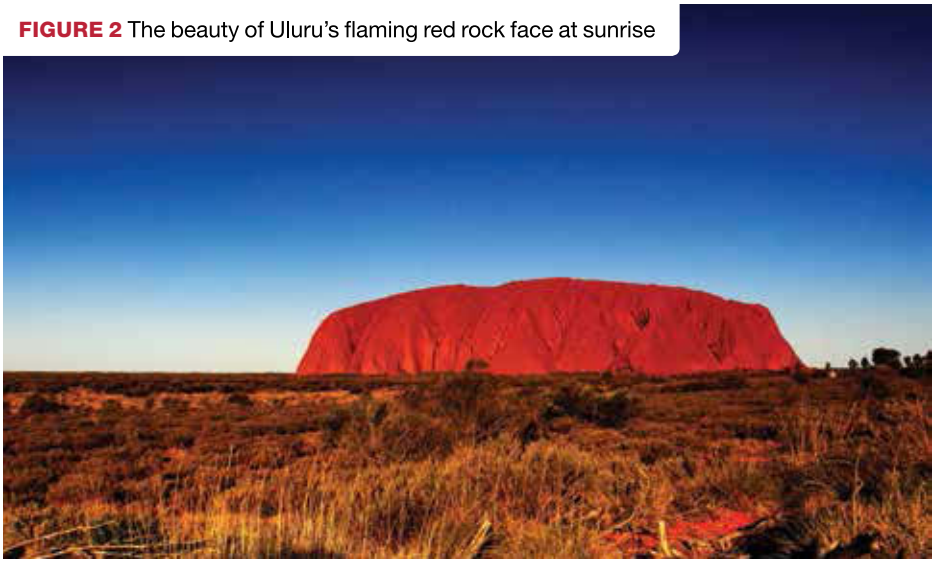
The colour of Uluru's rock face dramatically changes throughout the day. At sunrise, a popular time for tourists, it is flaming red (figure 2) then during the day it turns a red sandstone colour and at sunset it turns blue or violet. Its sheer size, shape and different colours have made this landform an inspiration and 'must see' place for its majestic beauty, awe and wonder.

3.8.2 Cultural and spiritual value

Uluru is a sacred place to the local traditional owners, the Anangu Aboriginal people. It has special meaning to them as they recount

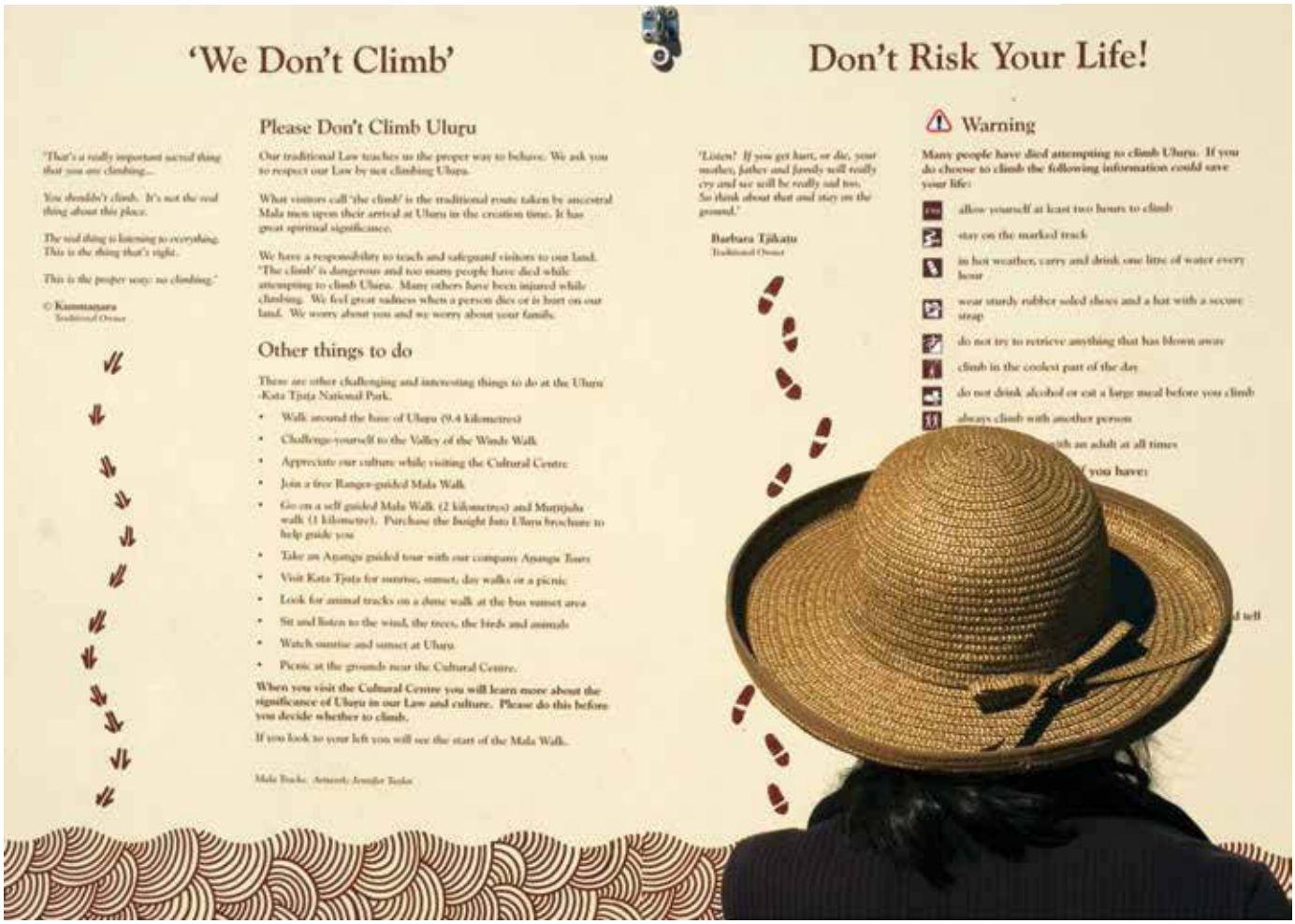
that their ancestors left behind the rock's many **fissures** and caves when it was created during the *Tjukurpa*, a name they give to their creation time. It is a site important to their spiritual beliefs with many ancient rock paintings of their ancestors inside the caves, and sacred rituals and ceremonies continue to be performed around the site. As it is a sacred place for Anangu, 'No Photography' signs are put up as a reminder to visitors to respect the Anangu's beliefs. Europeans have been visiting the site since the 1800s, and have enjoyed climbing the large rock for adventure and to appreciate the inselberg close up. However, as seen in figure 3, the Anangu have asked that they do not do this and many discussions over the years have focused on whether they should stop people climbing because of the cultural and spiritual importance of the site.

FIGURE 2 The beauty of Uluru's flaming red rock face at sunrise



fissure a long, narrow crack or opening in the face of a rock

FIGURE 3 Uluru is a sacred site and the Anangu request people do not climb this cultural and spiritual site.



3.8.3 Economic value

Regardless of its remote location, Uluru's uniqueness and beauty have made it a popular tourist destination making it an important source of money for the small community that live in the area. Over 257 000 people visited the region in 2014, and international guests made up 53 per cent of those who came. It is an isolated place, so tourists would stay an average of three nights and were spending $2506 per trip. This contributed $322 million to the economy as money was spent on accommodation, tour guides, airfares, eating out and paying to experience many cultural activities. Tourism also helps Indigenous people to earn an income whilst maintaining their link to the land. These cultural activities included guided tours of sites that are open to non-initiated people, viewing performances of songs and dance, campfire tours that demonstrate traditional hunting and gathering techniques, and the purchasing of the unique Aboriginal art.

FIGURE 4 Respecting sacred places



ACTIVITIES

IDENTIFY

1 What type of landform is Uluru?
2 What is the name of the creation time of the Anangu?

EXPLAIN

3 Why is Uluru important for the Anangu?
4 Refer to figure 2. Explain how we know this photo was taken at sunrise.
5 Uluru is important to the economy. Give reasons to support this statement.

APPLY

6 Looking at figure 4, what do you think this cartoon is trying to highlight about Uluru as a sacred space?
7 You are a travel agent, and you are responsible for creating a tour for your class to travel to Uluru. Create a travel itinerary including costs of airfare, tours, accommodation and eating out. Present it as a travel brochure.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Uluru

3.9 How is Uluru protected and managed?

3.9.1 Aboriginal management over generations

The area around Uluru has been home to the Anangu for hundreds of generations. They have been the guardians of the land long before the arrival of Europeans, and continue to play a role in managing the area today.

While the Anangu did not 'manage' the land in the modern sense, their way of life and spiritual connection to the landscape kept the country healthy. There is an obligation to look after one's country because of interconnection to the land, so the Anangu focused on using resources sustainably. Through detailed knowledge of the land, its habitats, their small population size and **nomadic lifestyle**, the Anangu made sure they did not place stress on the landscape and kept it pristine. By limiting access to the site to only sacred rituals, erosion on Uluru was lessened.

nomadic lifestyle describes a lifestyle in which people do not live in one fixed spot but move according to the seasons from place to place in search of food, water and grazing land

3.9.2 National park and joint management

Uluru has been managed as a national park since 1950. Ayers Rock (Uluru) and Mt Olga (Kata Tjuta) became the Ayers Rock/Mt Olga National Park in 1958, which saw it become a tourist and wildlife reserve. In 1975, the park was given more protection under a new federal government law. In particular, the law provided protection from tourism. In 1985 the Australian government returned the land back to the Anangu people who then leased it back to the government to help manage it. In 1992, the park's name was changed to Uluru–Kata Tjuta National Park to reflect the Aboriginal heritage of the land (figure 1). The Uluru–Kata Tjuta National Park has a joint management approach. This means that the Anangu and Parks Australia Rangers work together to help protect the landscape and unique landforms by using both scientific and Aboriginal knowledge to make decisions on how best to look after the area (figure 2).

FIGURE 1 The Uluru–Kata Tjuta National Park emblem



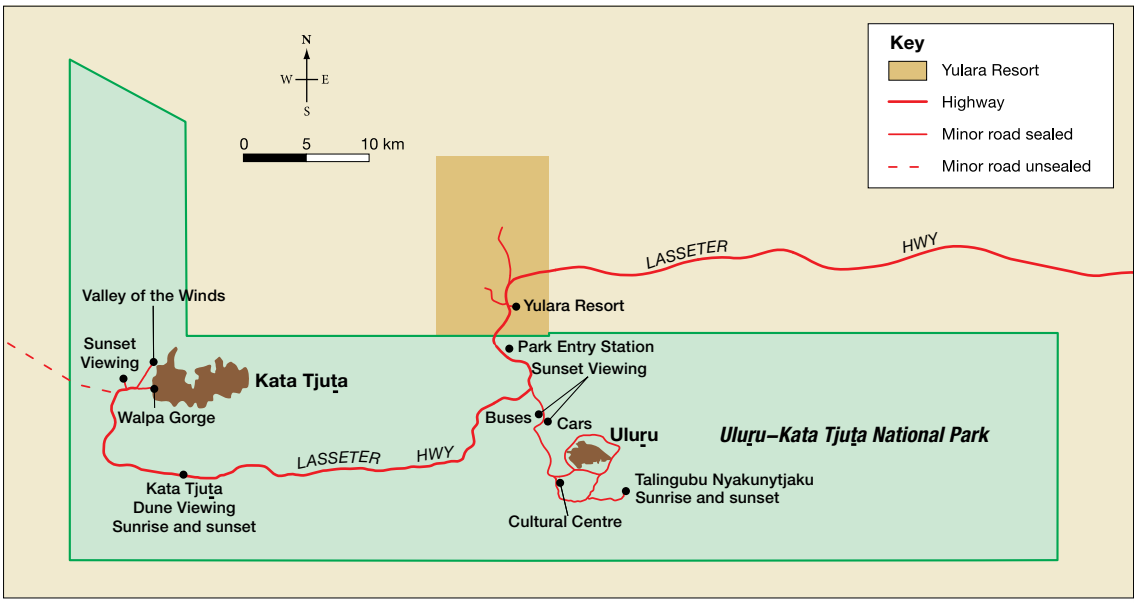
FIGURE 2 The Anangu and Parks Australia Rangers combine their knowledge to manage the park.



3.9.3 World Heritage listing

Uluru is a unique landform that is globally recognised. The Uluru–Kata Tjuta National Park was recognised as a World Heritage site with natural significance by UNESCO in 1987. In 1994, it became the second World Heritage site to be recognised by the World Heritage Committee as both a natural and cultural World Heritage site. The World Heritage listing puts more responsibility on the managers to preserve and protect the landscape not only for the local people, but also as a place of international importance. The World Heritage Area is the same as the whole National Park (figure 3). The Anangu and the Park Rangers work together to protect this World Heritage site for current and future generations to enjoy.

FIGURE 3 The Uluru–Kata Tjuta National Park and World Heritage site



Source: http://whc.unesco.org/document/119879

eBookplus

Weblink
Climbing Uluru

ACTIVITIES

IDENTIFY
1 Describe how the Anangu managed the area around Uluru before Europeans arrived.
2 What was the national park's main purpose after 1950?
3 What significant event in 1985 changed the way the national park was managed?

EXPLAIN
4 What were the three different names the national park has been known by and what is its current name?
5 Explain how joint management works.
6 Refer to the **Climbing Uluru** link in your eBookPLUS. Watch this video and list the reasons the managers give for not climbing Uluru.

INVESTIGATE
7 Research some management techniques that the Anangu and Park Rangers in Uluru–Kata Tjuta National Park use and create a fact file that identifies and describes the techniques.

APPLY
8 Refer to figure 1. Why do you think the national park's emblem reflects joint management?
9 Create an annotated timeline showing the significant events in Uluru's management.

PREDICT
10 Think–pair–share. With a partner, list what you think would have happened if Uluru was not managed and protected as a National Park and World Heritage site. What changes would have occurred? Share your findings with the class.

ice age a geological period during which the Earth is colder, glaciers and ice sheets expand and sea levels fall. The last ice age was approximately 13 000 years ago.

Anthropocene a period of time to describe the time when humans made significant changes to the Earth's environments

degradation a decline in quality caused by time or improper use

domesticate to tame a wild animal or plant so it can live with or be looked after by people

3.10 How have humans changed and degraded landscapes?

3.10.1 What human activities have degraded landscapes?

Humans depended on landscapes for their survival for thousands of years by living harmoniously within them. Since the end of the last **ice age**, humans began to settle in one place and made changes to the landscapes that surrounded them. Some scientists have named this period of time the **Anthropocene**. People built farms and settlements, such as towns and cities, and they used spaces for other industrial purposes such as mines. As a consequence, the built environments humans created have often resulted in the **degradation** of landscapes.

Farming

Humans moved from being nomadic to settling in one place. This happened because people discovered that they could grow crops and **domesticate** animals like cattle, sheep, goats and pigs. Since

humans no longer needed to migrate during different seasons to hunt and look for food, they changed the environment around them to farm more effectively. Farms need areas of clear flat land with good soil and access to water. Clear land often did not occur naturally, so humans removed many trees and other vegetation. Landscapes that often look natural now were altered by humans thousands of years ago (figure 1). The roots of trees help hold soil together and the falling organic material from plants and animals replaced the **nutrients** in the soil. However, removing the vegetation increased **erosion** and reduced the nutrients being replaced into the soil. Ploughing and irrigation also sped up **leaching** the nutrients out of the soil.

FIGURE 1 Once covered in vegetation, this Irish landscape in County Kerry was changed by the removal of trees for farming thousands of years ago.



Settlements

Since farming allowed humans to stay in one place they started to build large **settlements** to create communities with other people. Settlements began as small villages and some eventually turned into large towns or cities. To make way for housing, streets and other utilities landscapes needed to be cleared of vegetation and the ground excavated (figure 2). Cities and towns were very compact for many centuries, as most people had to walk around them. Since the invention of transport technologies, such as trains and motor vehicles, cities have expanded outwards to create suburbs (figure 3). Where once landscapes were dominated by natural elements, settlements have created large areas of built features that changed the landscape and reduced the size of habitats of many plant and animal species.

FIGURE 2 Impacts of spreading settlements



1. A new treeline is created after trees have been removed to clear land.
2. New surfaces change the pattern of water run-off and absorption.
3. Earth is excavated and the landscape reshaped.
4. New suburban houses are built.

FIGURE 3 Cities have expanded outwards to create suburbs. These have modified landscapes.



nutrient an essential element that feeds living things to help them function and grow

erosion the picking up, transport and depositing of weathered material

leaching a process that occurs where water runs through the soil, dissolving minerals and carrying them into the subsoil

settlement place where humans live together, e.g. houses, villages, towns and cities

CASE STUDY

Open cut mining

Mining for minerals, such as iron ore and coal, has been an activity humans have been involved in for thousands of years, and has provided many economic benefits and resources to communities. Open cut mining is an activity where humans excavate large holes in the earth to access the minerals they are seeking (figure 4). To access the minerals, miners remove the top layers of soil and dirt (overburden) and pile them up (figure 5). The mineral being mined is removed, but it is often mixed in with other substances that are not valuable so the waste is separated (tailings) and stored in large ponds that are engineered to keep the contaminated water away from the local environment. Previously, miners pumped tailings straight into local waterways, causing significant contamination and environmental degradation. Once all the valuable minerals have been removed from the mine a large pit is left called a final void. Unfortunately, in many parts of the world final voids are left and not backfilled as it is a costly exercise. Final voids that are not dealt with properly experience high rates of erosion, and there are concerns that they degrade water tables. Also, many believe the modern, large-scale open cut mining has degraded the aesthetics of the landscapes that were dug up by significantly changing the topography of the area.

FIGURE 4 Mt Tom Price Mine is a huge iron ore open cut mine in the Pilbara region in Western Australia.



FIGURE 5 Overburden piled up from an open cut mine



ACTIVITIES

IDENTIFY

1 Describe what the term degradation means.
2 State the name of the major climate event which occurred before humans started to make large impacts on landscapes.

EXPLAIN

3 Explain why humans were able to stop being nomadic.
4 Explain how farming has degraded soil.
5 Explain how settlements change landscapes.

INVESTIGATE

6 Research the Anthropocene and write a paragraph to explain what this period of time is.
7 Using the internet, research open cut mining and draw an annotated diagram that identifies and describes the basic features of an open cut mine.

lithosphere the Earth's crust, including landforms, rocks and soil

natural hazard an extreme event that is the result of natural processes and has the potential to cause serious material damage and loss of life

geomorphic describes a process that occurs in the lithosphere

mass movements large areas of earth that move

3.11 What are geomorphic hazards?

3.11.1 What is a landslide?

Geographers who study geomorphology examine the processes that shape and create the natural features of the Earth's crust. The layer of the Earth's crust they are interested in is called the **lithosphere**. **Natural hazards** are often events that happen in the natural environment that pose a threat to humans. A **geomorphic** hazard is any natural hazard that occurs in the lithosphere such as **mass movements**, glacial hazards, and soil erosion.

Landslides are a geomorphic hazard where loose rock, debris or earth moves down a steep slope. Landslides happen when the materials that make up the slope give way and move down because of gravity (figure 1). Landslides are known also as landslips, slumps or slope failure.

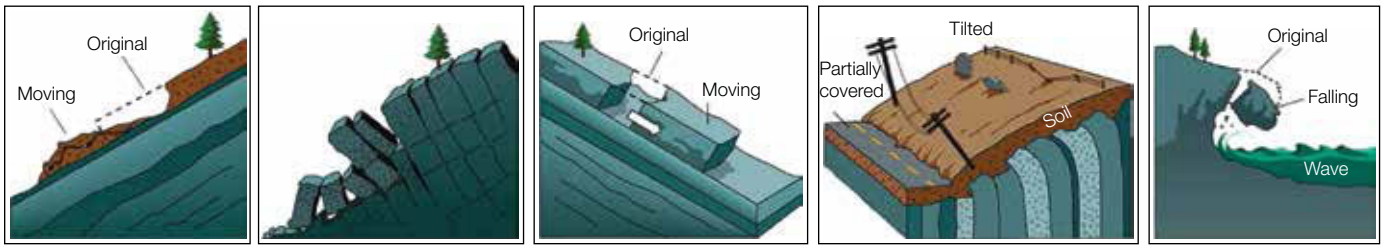
FIGURE 1 Travellers look at a landslide-affected road in Manali, India. Landslides are a regular hazard in this region.



What are the different types of landslides?

There are five categories of landslides (figure 2). The most dangerous type of landslide is a *flow*. They are called a flow because the rock and debris moves like water down the slope very quickly. A *fall* is where rock or debris free-falls before it rolls or slides down a slope. A *topple* is when rock tilts and does not collapse; often caused by the fissure pattern in a rock, similar to dominos toppling. A *slide* is a type landslide where large intact pieces of earth slip down another layer of a slope and often move slowly. *Spread* is when large areas of land creep slowly sideways over very gentle or flat terrain.

FIGURE 2 The different types of landslides



FLOW TOPPLE SLIDE SPREAD FALL

3.11.2 What are the causes of landslides?

Landslides can either occur naturally, be caused by humans or be caused and made worse by a combination of the two factors.

What are the natural causes of landslides?

Landslides that are caused naturally have three main triggers: (i) water, (ii) earthquakes and (iii) volcanic activity. Each of these triggers can occur independently or can work in combination with each other to cause a landslide.

Water

Slopes becoming saturated with water are one of the main causes of landslides. This can happen after lots of rain, as snow melts, or as a result of changes to water levels. Flooding and landslides are often related; as floodwater saturates the ground, loosening the earth, it creates the trigger for a landslide to happen.

Earthquakes

Areas that experience earthquakes often have landslide events. When the ground starts shaking it often loosens the material on steep slopes, causing a landslide or making the soil less compact, meaning water can saturate the ground quickly. Also, some materials when they shake can turn almost liquid, a process called liquefaction, and then they flow down a slope rapidly.

Volcanoes

When volcanoes erupt the lava can melt snow that then causes debris, such as ash, rock, soil and water, to flow down the slope. Volcanic debris is called *lahar*, an Indonesian word, and it flows very

rapidly, often leaving a trail of destruction. Also, the large volcanic explosion can cause earthquakes that then loosen the rock and create landslides.

Human causes

When humans move into an area they modify the landscape significantly. The roots of grass, plants and trees on slopes hold the soil together, but when removed, the earth is loosened creating conditions for a landslide. Digging out the bottom of a slope (undercutting) can change how steep a slope is and it also makes it top heavy. Human's use of water also contributes to landslides as the ground can be saturated by watering from farming (irrigation), drain pipes that leak and changing the way water flows when hard surfaces, such as roads, are created. All these factors, if not properly addressed by good engineering, can cause landslides.

3.11.3 What are the impacts of landslides?

Landslides can happen anywhere in the world with most countries experiencing them. Many landslides occur with minimal damage and no loss of life, but some of them have had disastrous impacts. In Australia, there have been 100 disastrous landslides recorded since 1842. These have killed 105 people and injured 129, and were mainly caused by human action (figure 3). One such disaster was the Thredbo Landslide on 30 July 1997. It killed 18 people, injured one person, and cost the government $40 million in compensation. This disastrous landslide occurred on a steep slope in the Thredbo village in the Kosciuszko National Park in NSW. Poor drainage was a contributing factor when the road was created above the village (figure 4).

Overseas, many poor communities are built on the side of steep hills due to the land being of poor quality and, therefore, the only place they can afford to live. They are at risk of being in a landslide, especially when heavy rains occur (see case study, page 68) having built housing on steep slopes.

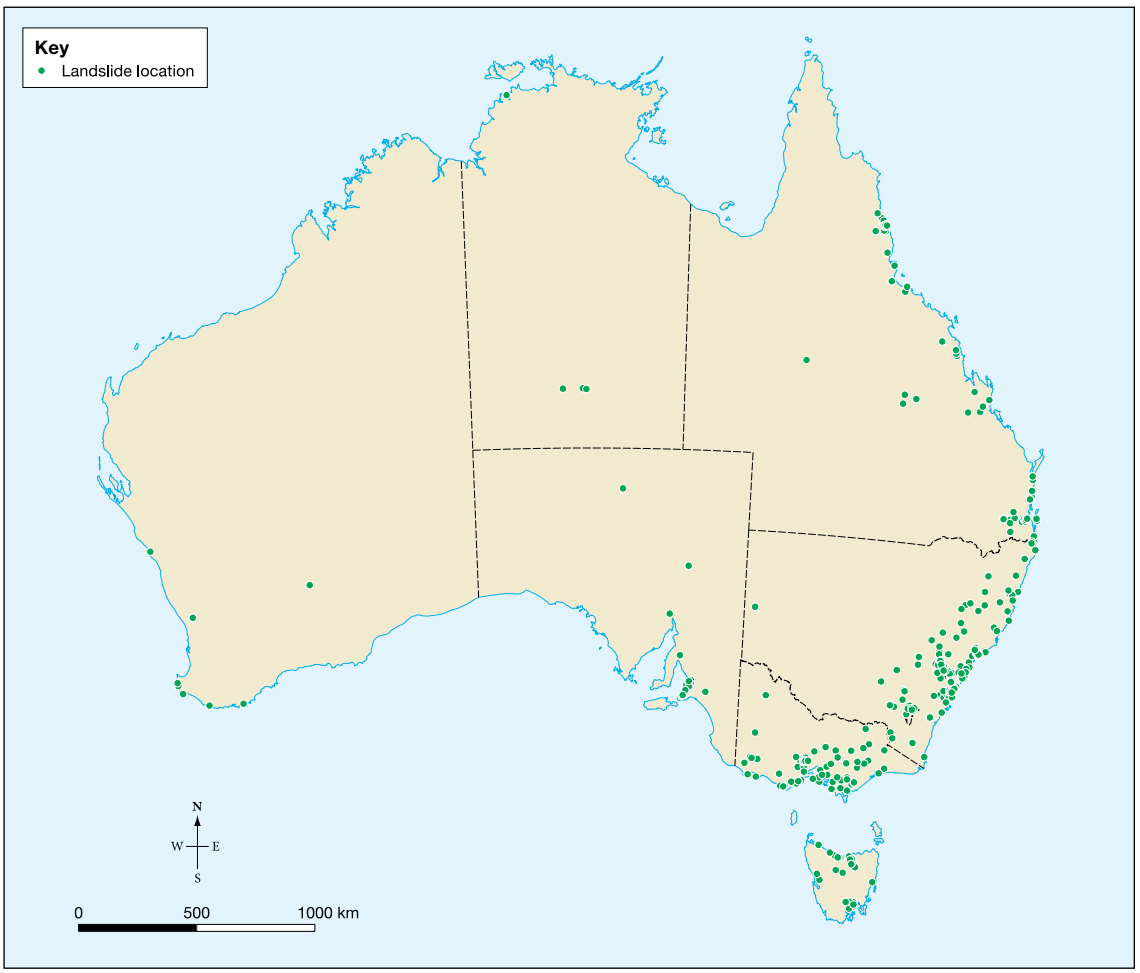


FIGURE 3 Locations of major landslides in Australia

Source: Geoscience Australia

FIGURE 4 The destructive path of the Thredbo Landslide





FIGURE 5 Signage used to warn people that landslides are a natural hazard in the area

3.11.4 Responding to landslides

After landslides occur, emergency services attend to assist with rescue and recovery. However, a preferred option is to try to minimise the impacts of landslides. Ideally, houses should not be built on land that is prone to landslides. If an area is prone to landslides, meshing can be used on the side to catch falling rocks, retaining walls are built where a hill has been undercut and signage is used to warn people of the dangers of landslides (figure 5).

CASE STUDY

Brazil landslides, April 2010

Between 6 April and 8 April in 2010, Rio de Janeiro experienced a high amount of rain due to a severe storm that saturated the ground that was already waterlogged. *Favela* is the name given to the slum-style housing that poorer people live in, and many favelas were built on steep slopes on the outskirts of the city. The saturated ground, the stresses put on the slope by removing the vegetation, and undercutting when building the houses caused massive flow landslides where it was heavily populated (figure 6). These landslides killed over 279 people, injured many more and left countless already poor people homeless.

FIGURE 6 A flow landslide on a steep slope on the outskirts of Rio de Janeiro



ACTIVITIES

IDENTIFY

1 Define the term geomorphology.
2 Describe what is a natural hazard.
3 Outline what is a geomorphic hazard.

EXPLAIN

4 Explain why a landslide is a geomorphic hazard.
5 Outline what changes to landscapes cause landslides.
6 Why is a flow landslide considered the most dangerous?
7 What caused the landslides in Brazil?
8 Create a table in your workbook and identify the different types of landslides and their causes. Then sketch a diagram showing how they occur.

APPLY

9 Refer to figure 3 and an atlas showing the physical characteristics of Australia. Using *positional language*, describe where most of Australia's landslides occur. What reasons can you give as to why landslides are occurring in these places?

PREDICT

10 Refer to figure 1. Using evidence from the photo, explain why this part of India has many landslides.
11 Using an online map, such as Google Maps or Google Earth, locate a site where landslides could occur in your area. Give reasons for your answer.

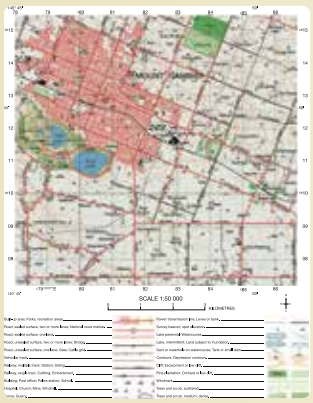
myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Thredbo Landslide

eBookplus ONLINE ONLY

3.12 SkillBuilder: Using topographic maps

What are topographic maps?

Topographic maps are a type of map that provides detailed and accurate information of features that appear on the Earth's surface. They show features of the natural environment, such as forests and lakes, and features of human environments, such as roads and settlements. Relief is often shown using contour lines.



eLesson
Watch this video to learn how to use topographic maps.



Searchlight ID: eles-1641

Interactivity
Try this interactivity to learn how to use topographic maps.



Searchlight ID: int-3137

3.13 What is the value of Gunnedah Shire?

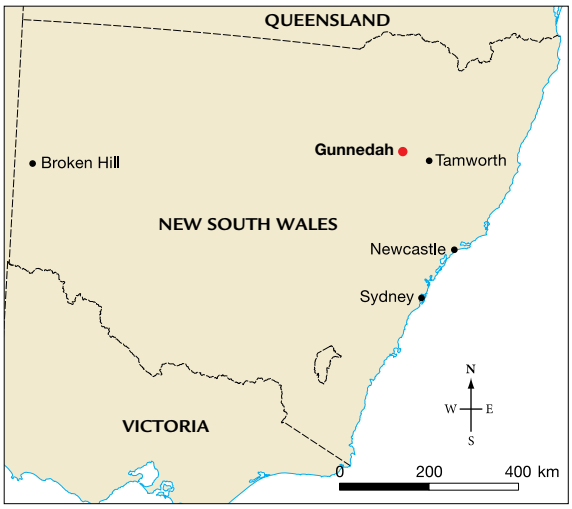


FIGURE 1 Location of Gunnedah

Source: Spatial Vision

3.13.1 Gunnedah Shire

Gunnedah Shire is located in NSW in the Namoi Valley, and is approximately 450 kilometres north-west of Sydney. It covers an area of 5092 square kilometres with the town of Gunnedah being the main regional centre.

Gunnedah was inhabited by the *Gunn-e-dar* people of the Kamilaroi nation and its name means 'place of white stones'. The area is situated on the Liverpool Plains so it is very flat. The plains are 264 metres above sea level and the highest hills are only 200 metres above the flat plains. As the area is flat, Gunnedah's main industry is agriculture with approximately 403 000 hectares of land used to grow crops such as wheat, sorghum, barley, cotton, sunflowers, soya beans and vegetables. Gunnedah also has a strong coal mining industry with 10 million tonnes of coal exported every year.

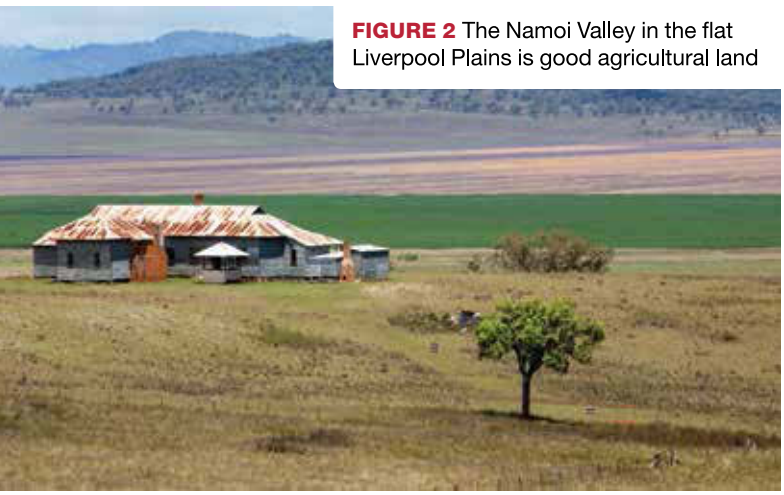


FIGURE 2 The Namoi Valley in the flat Liverpool Plains is good agricultural land



FIGURE 3 Aerial view of the Namoi Valley

ACTIVITIES

IDENTIFY

1 Refer to figure 4. Using your topographic map reading skills:
- **a** State the contour interval of this map.
- **b** State the ratio scale of the map.
- **c** Name the road in AR5671 and identify the type of road it is in the key.
- **d** How many buildings are located in AR5069?
- **e** What is the grid reference of the cemetery?
- **f** What is the height of the highest point on this map?
- **g** Name the main river evident on this map.
- **h** Name the major road evident on this map.

EXPLAIN

2 Refer to the text, figures 2, 3 and 4, and explain why farming is the main activity which occurs in this landscape.

INVESTIGATE

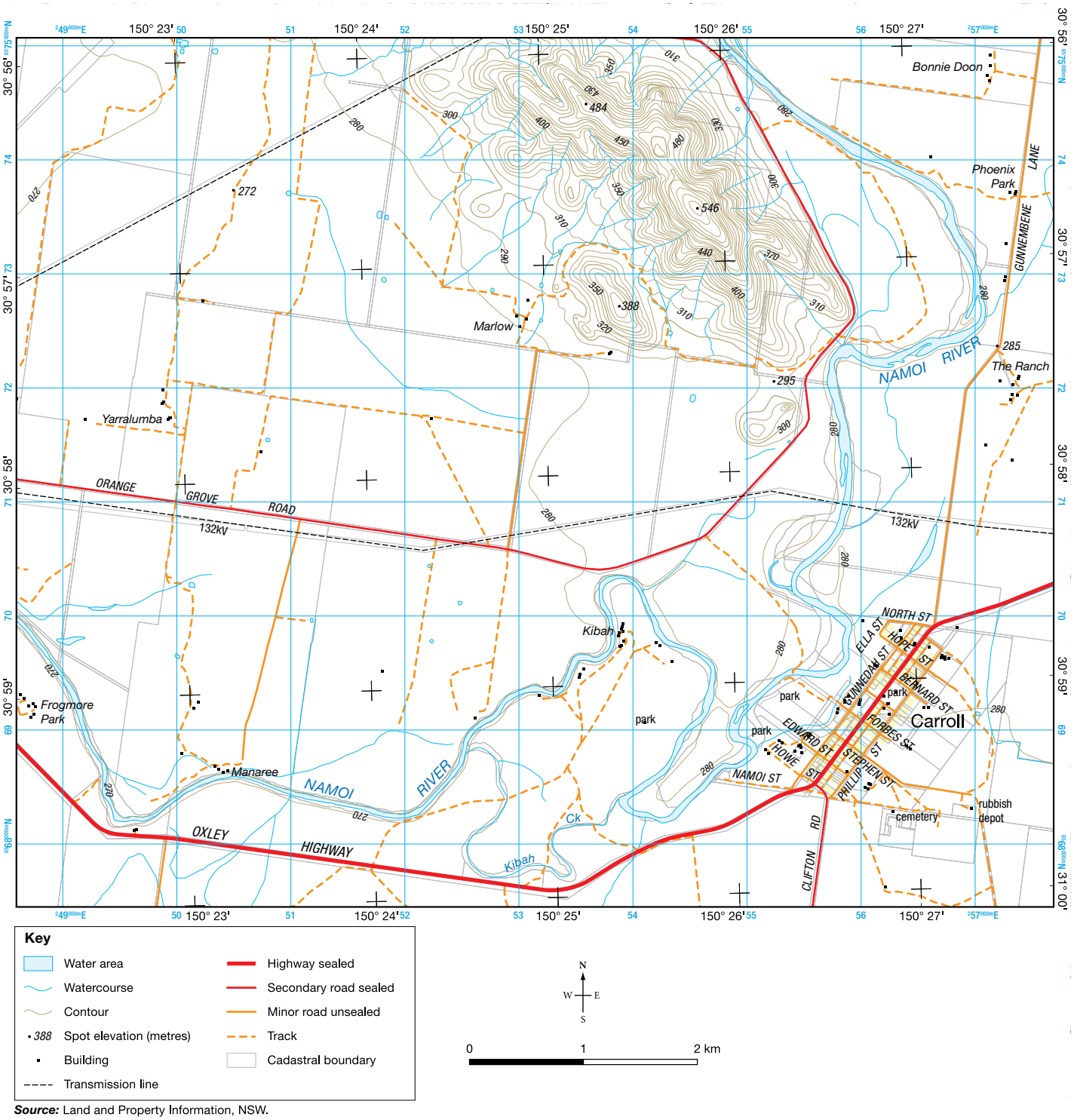
3 Use an online map, such as Open Street Map or Google Maps, and find the name of the town located in the south-east quadrant of this topographic map.

4 Why do you think the town was built in this space? What natural hazard would the town be under threat from?

APPLY

5 Choose an area on this map where you would establish a farm. Give the area reference and outline three reasons why you would locate a farm there.

FIGURE 4 Topographic map of Gunnedah Shire



Source: Land and Property Information, NSW.

eBookplus ONLINE ONLY

3.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

3.5 SkillBuilder: Using positional language

3.5.1 Tell me

What is positional language?

Positional language is the use of compass points to locate places and provide directions between places. A magnetic compass will always point to north. All other directions are taken from this reference point. An 8-point compass (figure 1) — north, north-east, east, south-east, south, south-west, west, and north-west — is standard in most geography books and atlases. A 16-point compass provides even further detail.

Why is positional language useful?

Positional language allows geographers to be accurate when giving directions and locations of places. It avoids confusion with positioning if the words such as left and right, up and down, top and bottom are used. No matter what direction you are facing, compass direction always remains the same, based around north.

Model

FIGURE 1 An 8-point compass

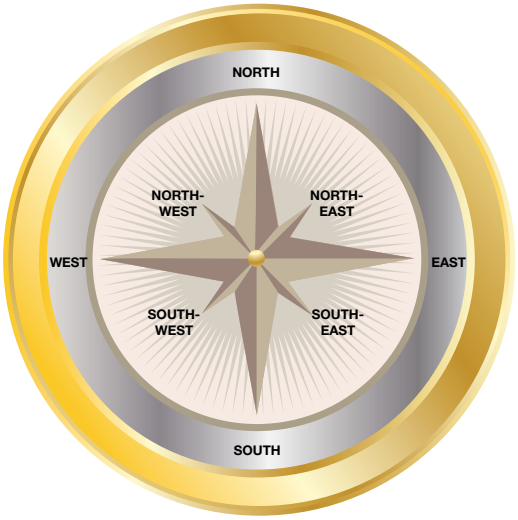
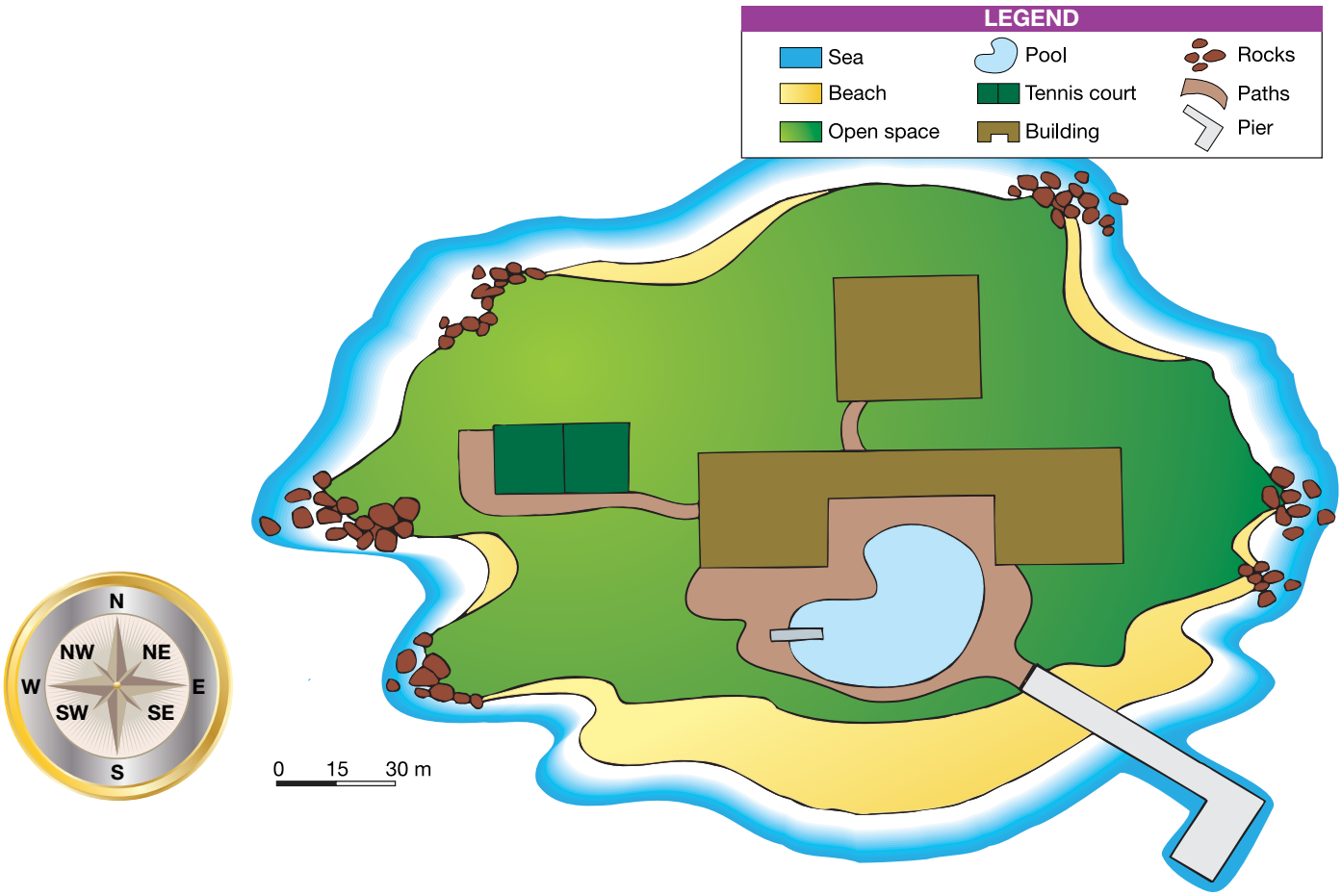


FIGURE 2 A cartographer's map of Holiday Island



As we check in at the main building for our stay on Holiday Island, a guide explains the features of the holiday resort. 'You arrived at the pier, which is to our south-east. On the way to this building you passed the paved poolside area, which is now to your south. There are four beach areas — the largest is to the south, a small moon-shaped beach is to the west and the other beaches are to the north-west and north-east across the open spaces. To the …'.

eBookplus

eLesson
Using positional language
Searchlight ID: eles-1649

3.5.2 Show me

How to use positional language

You will need:

- a map in your textbook (figure 3; also in subtopic 3.7 as figure 1)
- a pencil
- tracing paper.

Procedure:

Practising using the positional language of a 16-point compass can be done with any type of map such as in an atlas, street map, topographic map, a plan, sketch or an image such as aerial images, oblique images and satellite images.

STEP 1

On the piece of tracing paper draw a simple 16-point compass based on that shown in figure 1. Ensure that you mark the centre of the compass with a dot.

STEP 2

Place the centre of the 16-point compass (the dot) on the point of origin from which a direction is being given. Ensure that north is in the vertical position. On all maps/images, unless an indicator determines otherwise, north is assumed to be vertical (points to the top).

For example, to discover that place A is north-west of place B, this direction is taken from place B and so the centre of the compass is on place B.

STEP 3

Read the compass direction from the centre dot to the place identified and write down that direction.

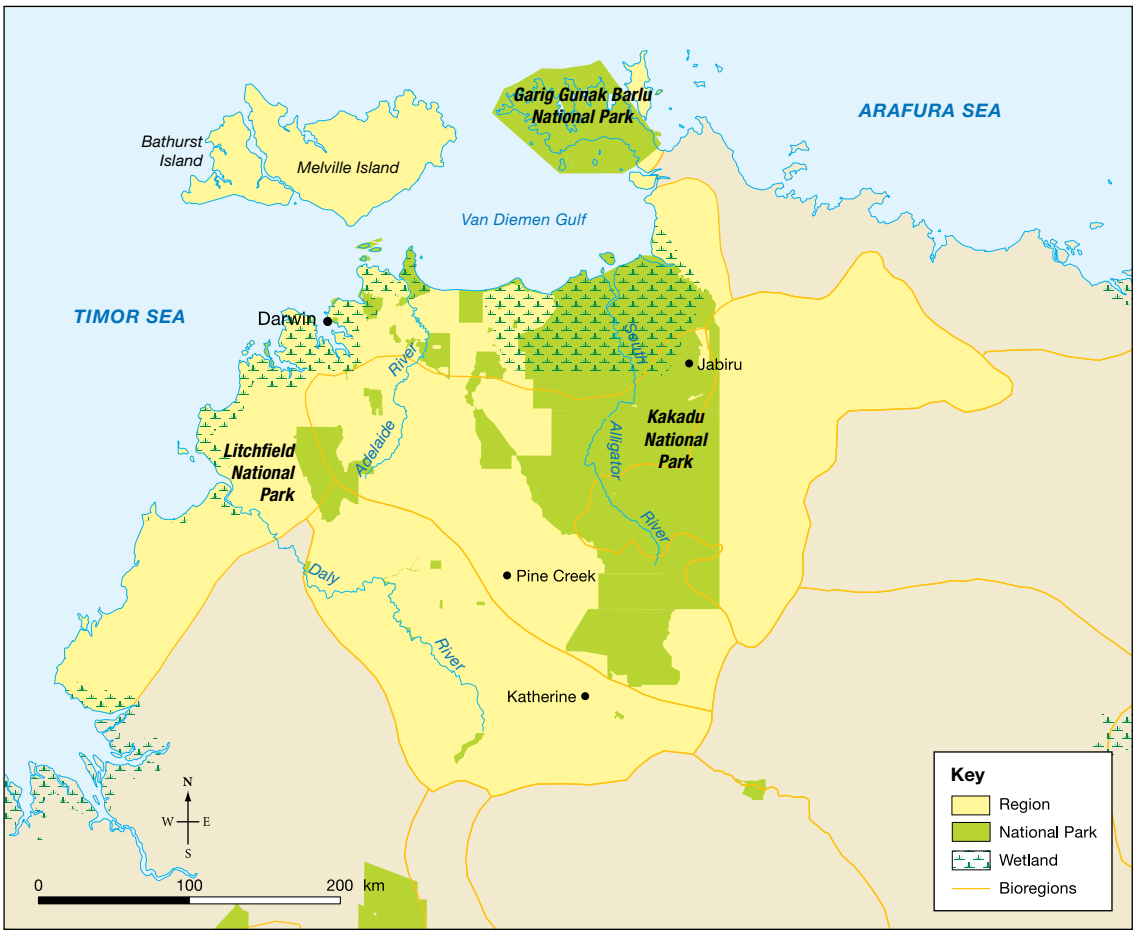
STEP 4

The placement of the centre of the compass must be moved for each individual direction required.

3.5.3 Let me do it

Developing my skills

FIGURE 3 Map of Kakadu National Park



Source: Spatial Vision

The completed example in the table below uses the map in figure 3 (also in subtopic 3.7 as figure 1) to show directions from one place to another place.

In this example, you are at Kakadu National Park and you want to give a direction so that someone arrives at Litchfield National Park.

Using your textbook and your tracing paper compass, create five more examples of positional language in the table below.

eBook*plus*

Interactivity
Using positional language
Searchlight ID: int-3145

Place of origin	Place of arrival	Direction
Kakadu National Park	Litchfield National Park	West

Ask a class member to check your directions.

Questions

1. In which direction from Katherine would you need to fly to get to Kakadu National Park?
2. In what direction is Jabiru in Kakadu National Park from Darwin?
3. In what direction is Jabiru from Pine Creek?
4. If I was to drive from Katherine in a north-west direction, would I arrive in Jabiru or Darwin?
5. I want to drive from Pine Creek to Jabiru. Describe the directions in which I would need to travel while on the road.

Checklist

I have:

- drawn and labelled an accurate 16-point compass.

Skills questions

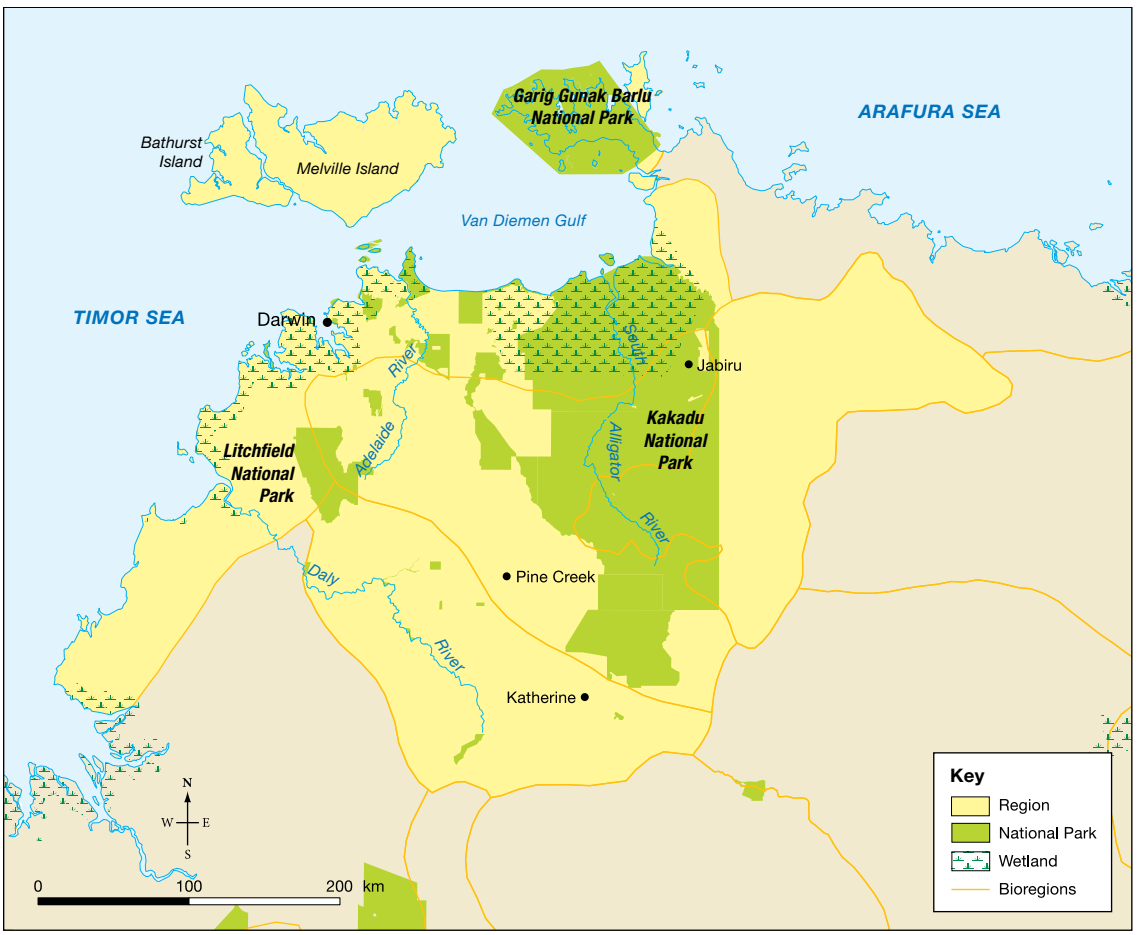
1. Compass points are used to:
   a. stop you getting lost
   b. find your way
   c. avoid confusion over directions
   d. make life difficult.
2. A 16-point compass is used to:
   a. provide more detail than an 8-point compass
   b. provide less detail than an 8-point compass
   c. provide the same amount of detail as an 8-point compass
   d. provide no information at all.
3. Why would north be used as the starting point for positional language?
4. When using a compass on a map or image in a textbook, why is it necessary to put the central dot on the ***place*** from which a direction is given?

3.7 Kakadu – Australia's first World Heritage Area

3.7.1 Kakadu's landscape

Kakadu National Park, as seen in figure 1, covers an area of approximately 20 000 square kilometres of the Northern Territory — an area roughly a third the size of Tasmania. It stretches 200 kilometres from north to south, and spans 100 kilometres from east to west. Within the boundaries of the park are vast uranium deposits. Kakadu is unusual in that it is recognised for both its natural beauty and its cultural value.

FIGURE 1 Map of Kakadu National Park

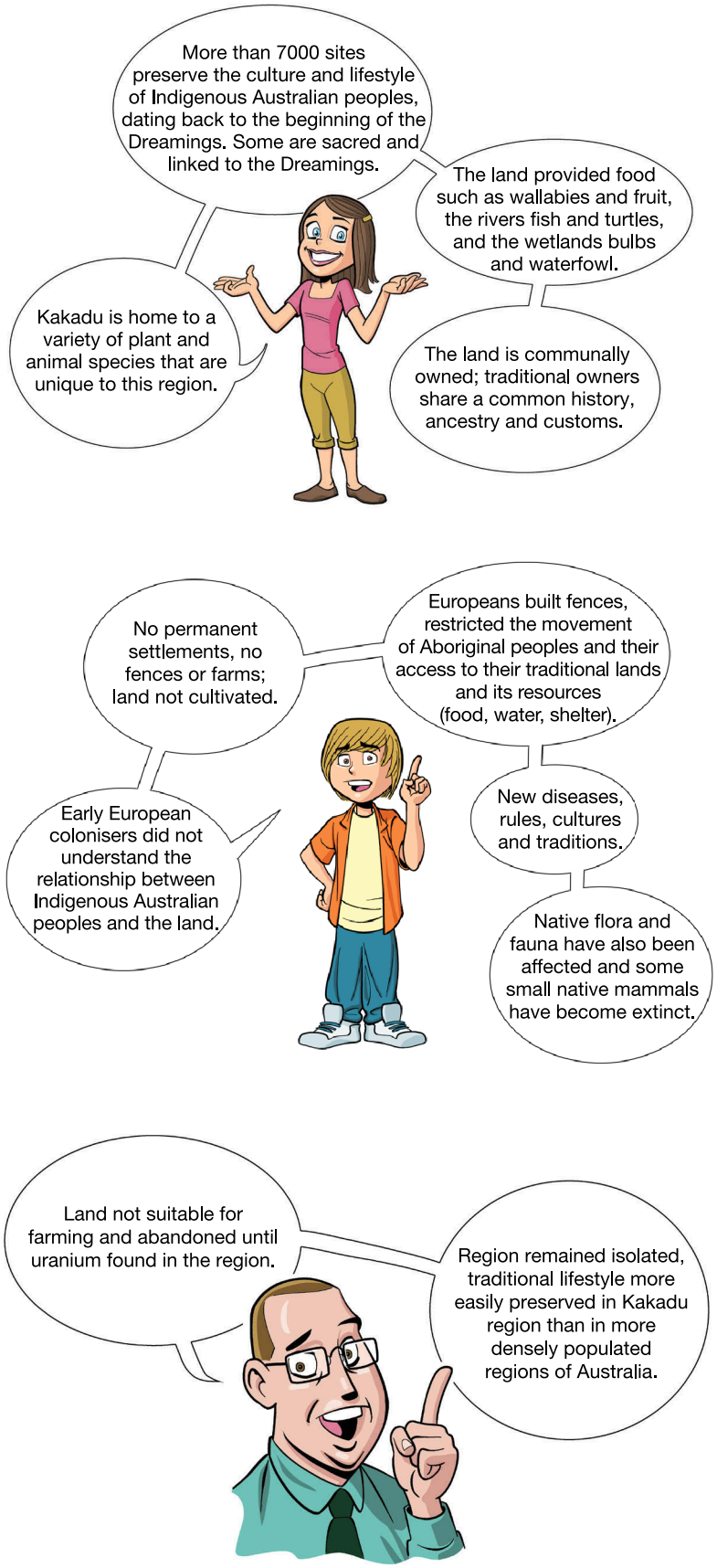


Source: Spatial Vision

3.7.2 World Heritage listing

In 1981 a large part of Kakadu became Australia's first World Heritage site. The World Heritage Committee saw that this landscape had natural beauty and cultural heritage that was ancient and continued to have links to present generations. More land was included in the Kakadu World Heritage Area in 1987, 1992 and 2011 all of which are managed and protected within the Kakadu National Park, Australia's largest land-based national park.

FIGURE 2 Why Kakadu is valued.



Source: © Glenn Lumsden

3.7.3 Kakadu and its resources

Kakadu is rich with the historical records and ancestry of the first Australians. In addition, it supports a treasure trove of native plant and animal species and provides a temporary home to a large number of migratory birds. More than 170 000 tourists visit Kakadu annually, attracted by its vast wetlands and scenery, including steep gorges, Aboriginal rock art, waterfalls such as Jim Jim Falls (see figure 3), and lookouts.

Kakadu also has vast deposits of uranium ore, which some regard as a valuable export for Australia. Opponents of uranium mining are concerned about the possibility that Australia's uranium could be processed and used to make nuclear weapons. Others fear the effects of mining on the environment and the potential for a devastating pollution event.

The Ranger uranium mine has been operating for 30 years and lies within the boundaries of Kakadu National Park. Three kilometres downstream from the mine, the Mirrar people (a local Aboriginal community) swim and fish. Since the mine opened, there have been more than 200 leaks and spills, and the mine has generated some 30 million tonnes of liquid radioactive waste.

FIGURE 3 Jim Jim Falls at Kakadu is a popular tourist destination.

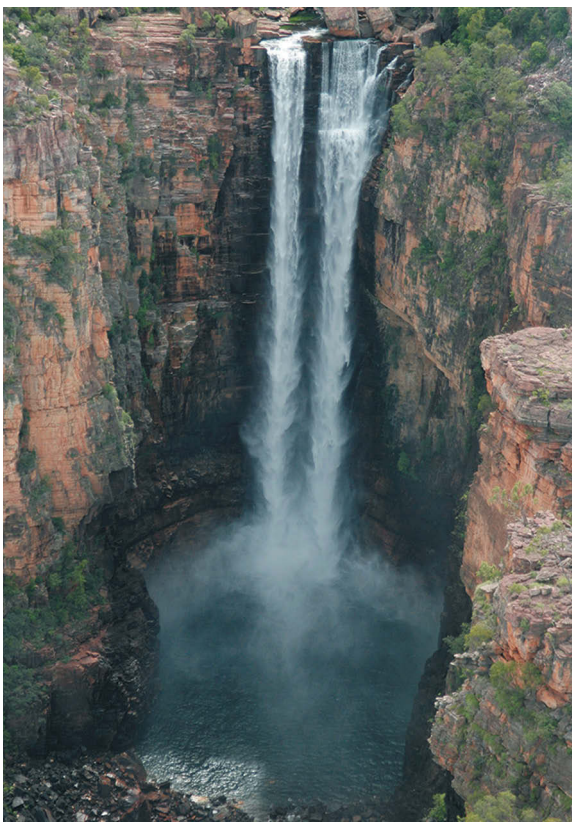
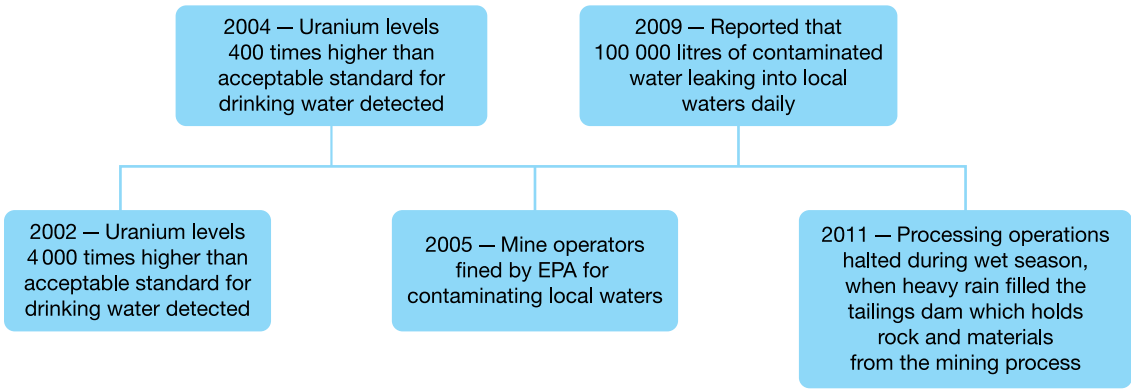


FIGURE 4 Timeline of major breaches at the Ranger uranium mine since 2002



ACTIVITIES

IDENTIFY

1 Where is Kakadu National Park and why is it important?

2 Copy the table below into your workbook and use it to compile a list of differences in the way the Australian landscape was viewed by Aboriginal and Torres Strait Islander peoples and non-Aboriginal and Torres Strait Islander Australians. The first one has been done for you.

Aboriginal and Torres Strait Islander peoples views	Non-Aboriginal and Torres Strait Islander views
The land is communally owned.	Individuals own the land.

EXPLAIN

3 a Where are the more densely populated regions of Australia? *Hint:* Find a map in your atlas that shows population distribution.

b Why would it be more difficult for Aboriginal and Torres Strait Islander communities in these areas to maintain their traditional lifestyle and culture?

4 Describe the ***interconnection*** that Aboriginal and Torres Strait Islander peoples have with the landscape.

5 a What is uranium used for and why is it considered a valuable resource?

b What risks does uranium mining pose in the Kakadu region?

PREDICT

6 a Suggest three possible impacts on the landscape if a new uranium mine was opened in the Kakadu region.

b Do you think ***changes*** would have a large-***scale*** or a small-***scale*** impact? Explain.

7 Why do you think the Australian government allows uranium mining in such an important region of Australia?

8 Predict what pressures decision-makers in Australia might face in future when balancing the needs of the different groups who have an interest in Kakadu's resources.

9 Write a letter to the editor of a newspaper outlining your views on uranium mining in ***environmentally*** sensitive areas. Explain whether you consider this type of activity is a ***sustainable*** use of the landscape.

3.12 SkillBuilder: Using topographic maps

3.12.1 Tell me

What are topographic maps?

Topographic maps are more than just contour maps showing the height and shape of the land. They also show features of the natural environment, such as forests and lakes, and features of human environments, such as roads and settlements. (Settlements are places where a community of people live.)

Why are topographic maps useful?

Topographic maps are useful when bushwalking, planning roads and checking the steepness of slopes. All topographic maps use similar symbols to show the main features in the landscape. These conventional symbols make it easy for map readers to quickly identify the features shown in the legend, or key.

Model

There are many observations that can accurately be made from a topographic map. Figure 2 is a topographic map extract of Mount Gambier. Blue Lake is a distinctive feature on this map, and it is surrounded by a steep slope. The built-up area, or township, is situated north of Blue Lake. A railway line passes through the town and the station is close to the civic centre and post office. The main town extends approximately four kilometres east–west and four kilometres north–south. The local golf club can be found in the north-east of town. These observations are made by using the legend, north arrow and scale.

FIGURE 1 This is an aerial photograph of Mount Gambier, South Australia, which has many extinct volcanoes. Lakes have formed in the craters of several volcanoes, the most famous of which is Blue Lake. We can see many features in the photo, but a topographic map can give us more information, especially about the shape of the landscape — its topography.



3.12.2 Show me

How topographic maps help us to locate places on a map

You will need:

- a topographic map.

Area and grid references

A 1-kilometre-square grid is overprinted on a topographic map. These grid lines are numbered with two-digit numbers in the map's margins. Lines that run up and down the map (north–south) are called eastings. The numbers increase as you move to the east. Lines that run horizontally across the map (east–west) are called northings. The numbers increase as you move north. In a grid reference, the eastings are given first, and then the northings.

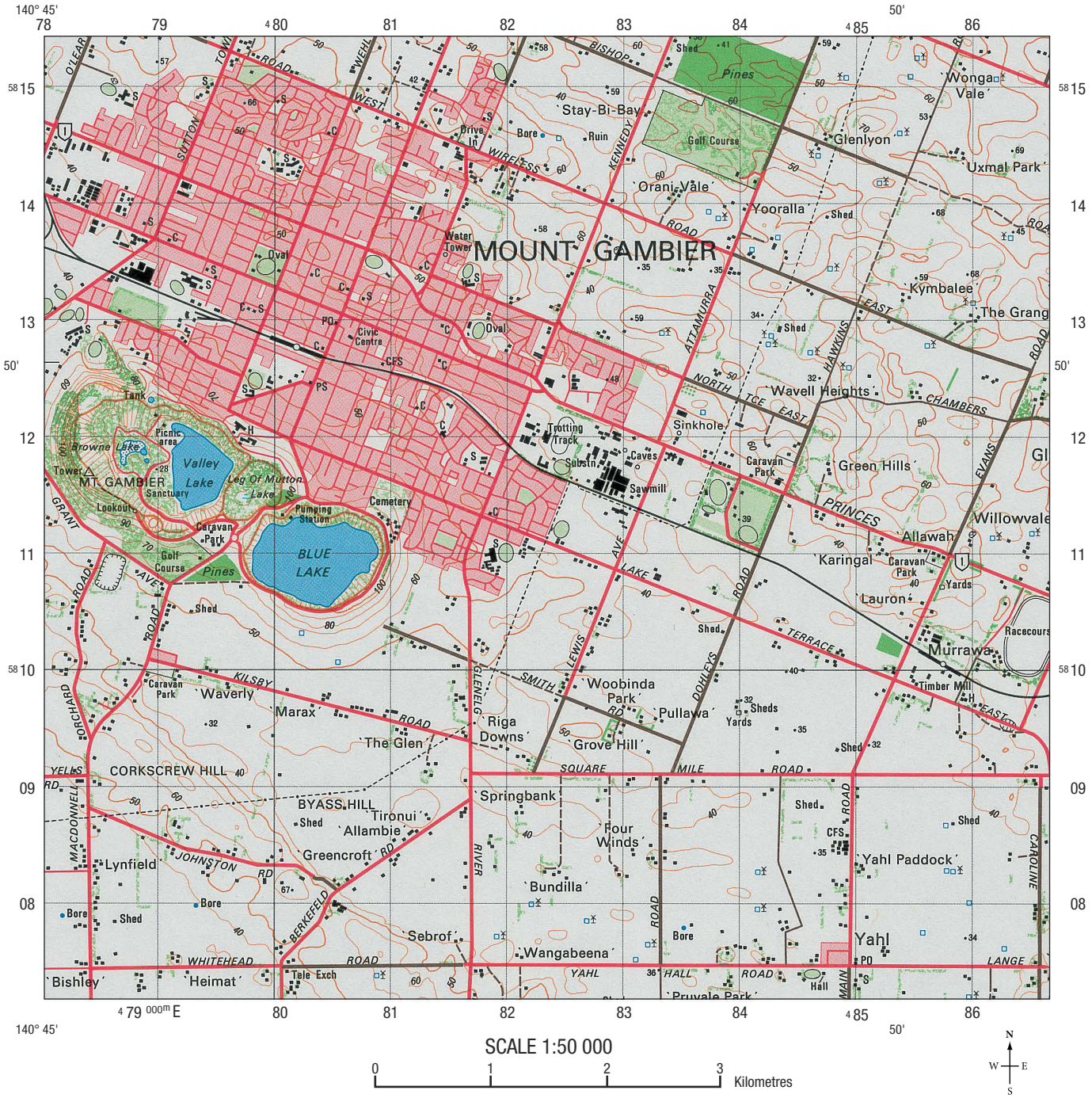
Four-figure grid references tell you the grid square in which to find a feature. The letters AR are placed in front of a four-figure reference to show the area reference. For example, AR8513 contains the town of Kymbalee.

Six-figure grid references pinpoint an exact point in the grid square. The third and sixth figures represent one-tenth of the distance between the two grid numbers. These divisions are not written on the map, so they must be estimated. The letters GR are used in front of a six-figure grid reference. There are no spaces between the digits in four- or six-figure references; for example, Kymbalee's grid reference is GR854132.

eBookplus

eLesson
Using topographic maps
Searchlight ID: eles-1641

FIGURE 2 This topographic map extract of Mount Gambier can be used to determine the location, direction and distance of physical and human features in the area shown on the map.



Built-up area; Parks, recreation areas.

Road, sealed surface, two or more lanes; National route marker.

Road, sealed surface, one lane.

Road, unsealed surface, two or more lanes; Bridge.

Road, unsealed surface, one lane; Gate; Cattle grid.

Vehicular track.

Railway, mulitple track; Station; Siding.

Railway, single tract, Cuttting; Embankment.

Building; Post office; Police station; School.

Hospital; Church; Mine; Windmill.

Fence; Guerry.

Power transmission line; Levee or bank.

Survey beacon; spot elevation.

Lake perennial; Watercourse.

Lake, intermittent; Land subject to inundation.

Dam or waterhole on watercourse; Tank or small dam.

Contours; Depression contours.

Cliff; Escarpment or low cliff.

Pine plantation; Orchard or low cliff.

Windmark.

Trees and scrub, scattered.

Trees and scrub, medium, dense.

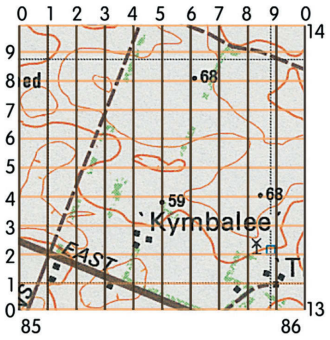
Source: Government of South Australia, Department of Environment, Water and Natural Resources.

3.12.3 Let me do it

Developing my skills

Answer these questions using the topographic map extract of Mount Gambier.

FIGURE 3 Working out a six-figure grid reference



eBook*plus*

Interactivity
Using topographic maps
Searchlight ID: int-3137

Questions

1. Examine figure 1. From which direction was this photograph of the crater lakes taken?
2. Examine figure 2. Look at the contour lines to the south of Blue Lake. Is the land flat or steep? How can you tell?
3. Sketch the special symbols used in the legend showing that the crater lakes:
   - form a depression
   - have steep sides.
4. Give the main features found at the following area references:
   - AR8010
   - AR8013.
5. Give area references for the following features:
   - Valley Lake
   - the racecourse.
6. Find the following features:
   - GR858087
   - GR816077
   - GR807128
   - GR812123.
7. From the topographic map extract of Mount Gambier, give six-figure grid references for features that show the following:
   - Mount Gambier has a large timber industry.
   - Mount Gambier is a popular tourist resort.
   - Mount Gambier has many sporting facilities.
   - Mount Gambier is the centre of a farming region.

Checklist

I have:

- identified north, south, east and west using the north point
- used the key to identify features
- used grid references to describe the location of a specific feature
- used the scale to calculate distances
- interpreted topography by considering how close together the contour lines are.

Skills questions

1. A topographic map is useful for working out:
   a. how the river level ***changes*** in high and low flow
   b. the shape of the land
   c. which birds are found in the area
   d. whether it is summer or winter.
2. Area references are used to:
   a. locate an exact point in the grid square
   b. calculate distance
   c. explain where buried treasure is located
   d. tell us the grid square that a feature is found in.
3. Identify the colours that have been used in the map legend for figure 2 and the type of landform feature that each represents.
4. Define the terms *eastings* and *northings* using sentences.
5. Which reading is given first: the easting or the northing?

3.14 Review

3.14.1 Review

1. a. Identify the four main reasons people value landscapes and landforms.
   b. Create a table in your workbook, like the one below, and insert the four main 'values' on why people value landscapes and landforms into the column heading. Provide an explanation and give examples for each value.

Value
Explanation
Example

2. Why is there a strong link between the beach landscape and Australia's cultural identity?
3. Explain how the Dreaming shows that Aboriginal spirituality and culture are influenced by landscapes and landforms.
4. Outline how tourism helps people value landscapes and landforms.
5. a. Identify and describe ONE strategy at the global ***scale*** that helps protect and manage landscapes and landforms.
   b. Identify and describe ONE strategy at the local ***scale*** that helps protect and manage landscapes and landforms.
6. a. What does the term *anthropocene* mean?
   b. Why are geographers concerned with the *anthropocene*?
7. a. What is a geomorphic hazard?
   b. Identify and explain one type of geomorphic hazard.

3.14.2 Reflect

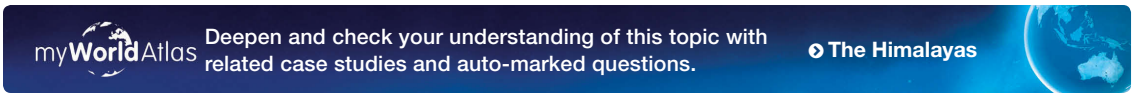
8. Think about a landscape or landform that you have seen or visited. Outline some reasons why it should be protected and managed.
9. ***Place*** is an important concept in Geography. Explain this concept and refer to Uluru as an example of place to the Aboriginal people.
10. Refer to the **Himalayas video** myWorld Atlas link in the Resources tab and the image below on Mt Everest and the Himalayas.

FIGURE 1 Mt Everest



a. Why do you think people are attracted to Mt Everest?
b. What is the name of the community that lives near Mt Everest and how does the video show it has spiritual value?
c. Why do you think Mt Everest has economic value for the local community and wider global community?

11. a. Humans have degraded many landscapes and landforms. Identify and describe some ways that humans have degraded them.
b. Do you think it is possible for people to become more modern without degrading landscapes and landforms? Justify your answer.
12. Thinking about where you live and places you visit, what is the risk of you witnessing or being affected by landslides? Justify your answer.





Arches in a desert landscape, Utah, United States

CHAPTER 4

Desert landscapes

4.1 Overview

4.1.1 Introduction

Approximately one-third of the Earth's land surface is desert — arid land with little rainfall. These arid regions may be hot or cold.

The actions of wind and, sometimes, water shape the rich variety of landscapes found there.

Starter questions

1 Have you ever visited a desert? Where was it? Why did you go?
2 Make a list of the geographical characteristics of desert areas. What is the most common feature of a desert?
3 Find a description of a desert online. Copy the text and use the **Wordle** weblink in your eBookPLUS to create a Wordle. What is the most common word in your Wordle? Why do you think this is the case?
4 Use the **Sahara** weblink in your eBookPLUS to watch a video of desert sandstorms.
  a Describe the sandstorm you see. Would it be difficult for people to cope with such an event?
  b Describe how some animals are adapted to cope with desert sandstorms.
  c How do the wind and sand shape the desert?

eBookplus

Weblinks
- Wordle
- Sahara

Inquiry sequence

		Syllabus outcomes
4.1 Overview		
4.2 What is a desert?		GE4-1, GE4-7, GE4-8
4.3 What type of climate forms deserts?		GE4-1, GE4-2, GE4-7, GE4-8
4.4 What are the processes that shape desert landforms?		GE4-1, GE4-2, GE4-8
4.5 What are the characteristics of Australia's deserts?		GE4-1, GE4-2, GE4-8
4.6 How did Lake Mungo become dry?		GE4-2, GE4-5, GE4-7, GE4-8
4.7 How do people use deserts?		GE4-4, GE4-5, GE4-7, GE4-8
4.8 SkillBuilder: Using latitude and longitude	eBookplus ONLINE ONLY	GE4-7
4.9 SkillBuilder: Calculating distance using scale	eBookplus ONLINE ONLY	GE4-7
4.10 Investigating topographic maps: How do people manage deserts?		GE4-5, GE4-7, GE4-8
4.11 Is Antarctica a desert?	eBookplus ONLINE ONLY	GE4-1, GE4-2, GE4-7, GE4-8
4.12 How do people use Antarctica?	eBookplus ONLINE ONLY	GE4-4, GE4-5, GE4-7, GE4-8
4.13 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Desertscapes
Searchlight ID: eles-1625

4.2 What is a desert?

4.2.1 Defining a desert

A desert is a hot or cold region with little or no rainfall. Around one-third of the Earth's surface is desert and is home to about 300 million people.

Although they receive little rainfall, most deserts receive some form of precipitation. When it does rain, it is usually during a few heavy storms that last a short time.

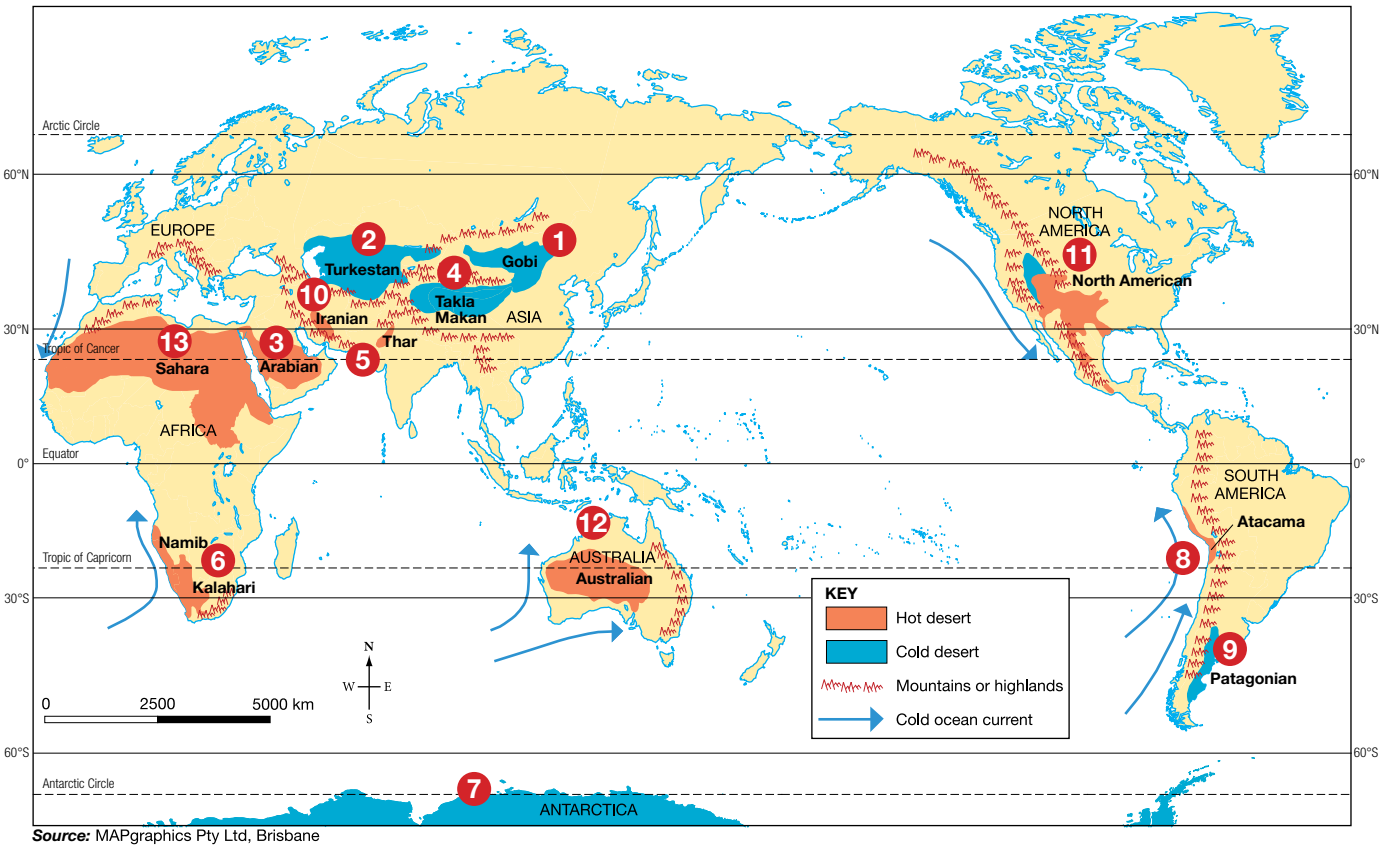
TABLE 1 Types of deserts

Rainfall (mm/year)	Type of desert	Examples
<25	Hyper-arid	Namib; Arabian
25–200	Arid	Mojave
200–500	Semi-arid	Parts of Sonoran Desert

Hot deserts

Most of the world's hot deserts are located between the Tropic of Cancer and the Tropic of Capricorn (see figure 1). They have very hot summers and warm winters. Temperature extremes are common, because cloud cover is rare and humidity is very low; this means there is nothing to block the heat of the sun during the day, or prevent its loss at night. Temperatures can range between around 45 °C and –15 °C in a 24-hour period.

FIGURE 1 The distribution of the world's deserts



Source: MAPgraphics Pty Ltd, Brisbane

Cold deserts

Cold deserts lie on high ground generally north of the Tropic of Cancer and south of the Tropic of Capricorn (see figure 1). They include the polar deserts. Any precipitation falls as snow. Winters are very cold and often windy; summers are dry and cool to mild.

4.2.2 Deserts of the world

1 Gobi Desert

Asia's biggest desert, the Gobi, is a cold desert. It sits some 900 metres above sea level and covers an area of some 1.2 million square kilometres. Its winters can be freezing.

FIGURE 2 The Gobi, an example of a cold desert



2 Turkestan Desert

The cold Turkestan Desert covers parts of south-western Russia and the Middle East.

3 Arabian Desert

This hot desert is as big as the deserts of Australia. Towards its south is a place called Rub al-Khali (meaning 'empty quarter'), which has the largest area of unbroken sand dunes, or erg, in the world.

4 Takla Makan Desert

The Takla Makan Desert is a cold desert in western China. Its name means 'place of no return'. The explorer Marco Polo crossed it some 800 years ago.

5 Thar Desert

The Thar Desert is a hot desert covering north-western parts of India and Pakistan. Small villages of around 20 houses dot the landscape.

6 Namib and Kalahari deserts

The Namib Desert extends for 1200 kilometres down the coast of Angola, Namibia and South Africa. It seldom rains there, but an early-morning fog often streams across the desert from the ocean. The dew it leaves behind provides moisture for plants and animals. It joins the Kalahari Desert, which is about 1200 metres above sea level.

7 Antarctic Desert

The world's biggest and driest desert, the continent of Antarctica, is another cold desert. Only snow falls there, equal to about 50 millimetres of rain per year.

8 Atacama Desert

The Atacama Desert is the driest hot desert in the world. Its annual average rainfall is a tiny 0.1 millimetre.

9 Patagonian Desert

The summer temperature of this cold desert rarely rises above 12 °C. In winter, it is likely to be well below zero, with freezing winds and snowfalls.

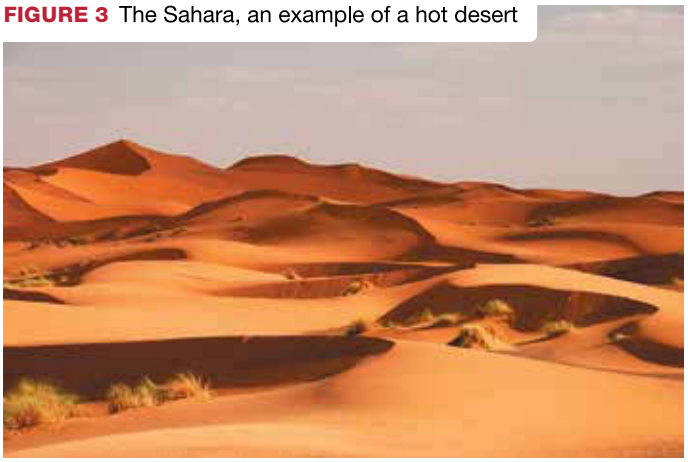
10 Iranian Desert

Two large deserts extend over much of central Iran. The Dasht-i-Lut is covered with sand and rock, and the Dasht-i-Kavir, mainly in salt. Both have virtually no human populations.

11 North American deserts

The desert region in North America is made up of the Mojave, Sonoran and Chihuahuan deserts (all hot deserts) and the Great Basin (a cold desert). The Great Basin's deepest depression, Death Valley, is the lowest point in North America.

FIGURE 3 The Sahara, an example of a hot desert



12 Australian deserts

After Antarctica, Australia is the driest continent in the world. Its deserts are generally flat lands, often vibrant in colour.

13 Sahara Desert

The largest hot desert in the world, the Sahara stretches some nine million square kilometres across northern Africa over 12 countries. Only a small part is sandy. It is the sunniest place in the world (see figure 3).

eBook*plus*

Interactivity
Great deserts of the world
Use this interactivity to check your knowledge of some of the main hot and cold deserts of the world
Searchlight ID: int-3106

ACTIVITIES

IDENTIFY
1 What climate conditions are needed for hot and cold deserts to form?
2 Where is the sunniest ***place*** in the world?
3 Name three deserts in the Asia–Pacific region.

EXPLAIN
4 Describe key differences between hot and cold deserts.

INVESTIGATE
5 Look carefully at the map in figure 1, and the text.
- **a** Which continent has the largest area of hot desert?
- **b** Which continent has the largest area of cold desert?
- **c** What is the largest hot desert in the world?
- **d** What is the largest hot desert in the Asia–Pacific region?
- **e** Which is the driest continent in the world?
- **f** Which continent contains the driest hot desert?
- **g** Which North American desert contains the lowest land on the continent?

APPLY
6 Use the information in this section to design a quiz of 10 questions entitled 'Deserts of the world'. Test your friends and family.
7 Draw up and complete a table like the one below to show your understanding of the locations and features of desert ***environments***. Look for photos on the internet.

Name of desert	Mountain range	Continent	Ocean current	Photos

4.3 What type of climate forms deserts?

4.3.1 The subtropics

Deserts form in many different parts of the globe: the subtropics; continental interior areas at middle latitudes; on the leeward side of mountain ranges; along coastal areas; and in the polar regions. The only common factor is their low rainfall — but why do these areas experience low rainfall?

Most of the world's greatest deserts are found in the subtropics near the Tropics of Cancer and Capricorn.

Because of the way the Earth rotates around the sun, areas around the equator receive more direct sunlight than anywhere else on Earth. This means the air there is always very hot. Hot air can hold much more moisture than cold air, so the **humidity** in these areas is always very high. Hot air also rises. As the air heads upwards into the atmosphere above the equator, it drifts away, heading north and south.

humidity the amount of water vapour in the atmosphere

The higher the air gets, the cooler it becomes. Cool air can't hold as much moisture, so it releases it as rain. Areas around the equator and to the immediate north and south of it (the tropics) receive frequent heavy downpours (see figure 1).

With its moisture gone, the cool, dry air continues moving north and south away from the equator until it meets zones of high air pressure around the tropics. Here, it is forced downwards. The more the dry air descends, the warmer it gets. This means it can hold more moisture and it is likely to absorb any moisture that already exists in this environment. It is like using a sponge to wipe up some water on the kitchen bench; a dry sponge will absorb more of the spill than a wet sponge. This is how the subtropical deserts form.

FIGURE 1 The formation of subtropical deserts in Africa

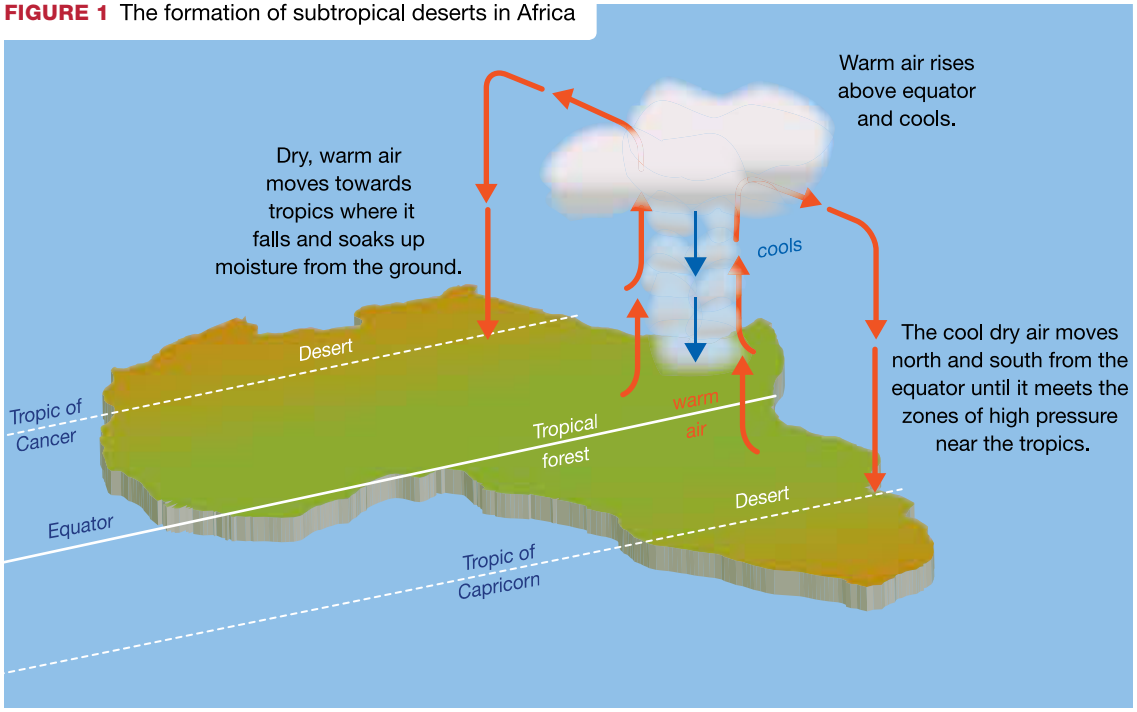


FIGURE 2 The Sahara Desert of northern Africa is the world's largest and can experience temperatures as high as 57 °C.



Temperatures in these deserts are usually high all year round. In summer the heat is extreme, with daytime temperatures often going above 38 °C and sometimes as high as 49 °C. At night — with no clouds to provide insulation — temperatures drop quickly to an average of 21 °C in summer and sometimes below freezing during winter.

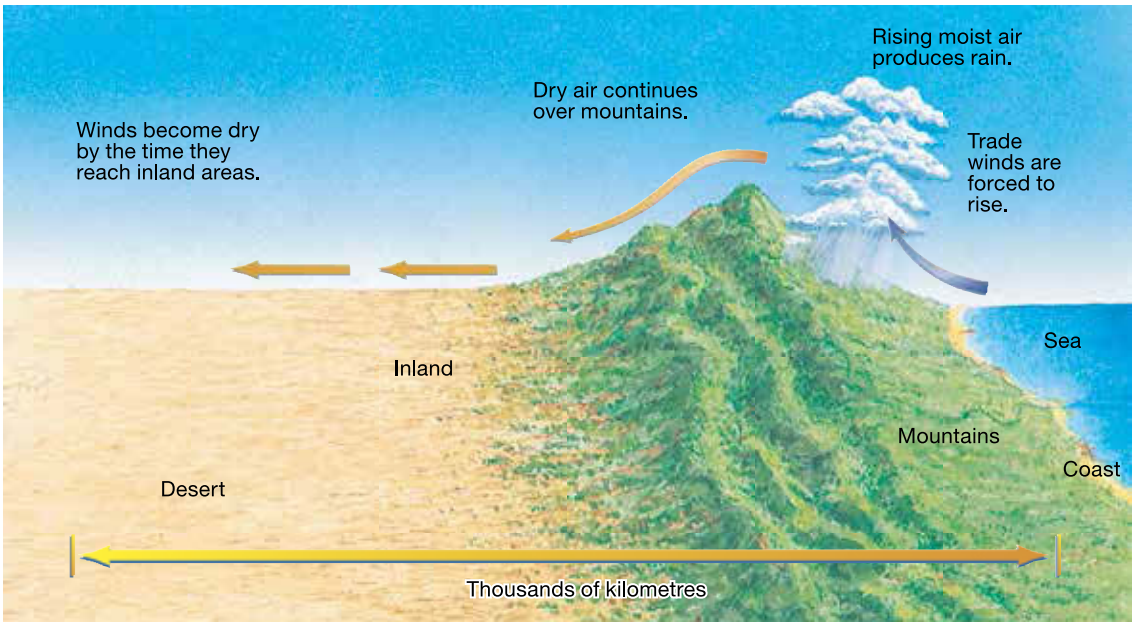
4.3.2 Rain-shadow deserts

Rain shadows form on the leeward side of a mountain range (opposite the windward side that faces rainbearing winds). Deserts commonly form in rain shadows.

rain shadow the drier side of a mountain range, cut off from rain-bearing winds

- Moist air blowing in from the ocean is forced to rise up when it hits a range of mountains. This cools the air. As cool air cannot hold as much moisture, it releases it as precipitation falling on the windward side of the mountain (see figure 3).
- By the time the air moves over the top of the range and down the other side, it is likely to have lost most, if not all, of its moisture. It will therefore be fairly dry.
- The more the air descends on the other side of the range, the more it warms up. Hence, it can hold more moisture. So, as well as not bringing any rain to the land, the air absorbs what little moisture the land contains.
- In time, as this pattern continues, the country in the rain shadow of the mountain range is likely to become arid (see figure 3).

FIGURE 3 The formation of rain-shadow deserts

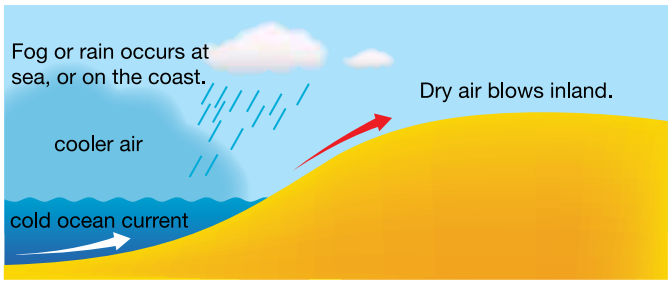


An example of this effect is the Great Dividing Range in Australia; cool moist air produces rainfall on the eastern side of these mountains and desert to the west. The Mojave Desert in the south-western United States is located on the leeward side of the Sierra Nevada mountain range.

4.3.3 Coastal deserts

Currents in the oceans are both warm and cold, and are always moving. Cold currents begin in polar and temperate waters (with moderate temperatures), and drift towards the equator. They flow in a clockwise pattern in the northern hemisphere, and in an anticlockwise pattern in the southern hemisphere. As they move, they cool the air above them (see figure 4).

FIGURE 4 The formation of coastal deserts



If cold currents flow close to a coast, they can contribute to the creation of a desert. This occurs because cold ocean currents cause the air over the coast to become stable, which stops cloud formation. If the cool air the currents create blows in over warm land, the air warms up; it can then hold more moisture (see figure 4). It is therefore not likely to release any moisture it contains unless it is forced up by a mountain range. Large coastal deserts, including the Atacama Desert in Chile and the Namib Desert in Namibia, are formed in this way (see figure 5).

FIGURE 5 The coastal Namib Desert



eBook*plus*

Interactivity
How to make a desert
Use this interactivity to check your understanding of the ways deserts are created.
Searchlight ID: int-3107

4.3.4 Inland deserts

Some deserts form because they are so far inland that they are beyond the range of any rainfall. By the time winds reach these dry centres, they have dumped any rain they were carrying or have become so warm they cannot release any moisture they still hold. The air that enters such areas is usually extremely dry and the skies are cloudless for most of the year. Summer daytime temperatures can rise as high as those of subtropical deserts. In winter, however, temperatures are much lower. Average daily temperatures below freezing are common during winter.

Examples of inland deserts are the central deserts of Australia (see figure 6), the Thar Desert in north-west India and the vast Gobi and Taklimakan deserts of Central Asia.

FIGURE 6 The Simpson Desert in central Australia



4.3.5 Polar deserts

Polar deserts are areas with a precipitation rate of less than 250 millimetres per year and an average temperature lower than 10 °C during the warmest month of the year. Polar deserts cover almost five million square kilometres of our planet and consist mostly of rock or gravel plains. Snow dunes may be present in areas where precipitation occurs. Temperatures in polar deserts often alternate between freezing and thawing, a process that can create patterned textures on the ground as much as five metres across.

FIGURE 7 Although covered in frozen water, Antarctica receives little rain and is therefore classified as a desert.



FOCUS ON FIELDWORK

Investigating your local climate: Using weather instruments

Setting up a weather station around your school is a great way to get an accurate record of your local climate. Set up a rain gauge and a thermometer in an unobstructed area around the school. Check the measurements once or twice a day to keep a record throughout the month, term or even the year. Use this information to create a climate graph of your school.

1. How does the school's temperatures and rainfall compare to local weather reports?
2. Could anything be influencing the temperature or rainfall around the weather station?
3. How does the temperature and rainfall influence the plants around the school?

FIGURE 8 A weather station



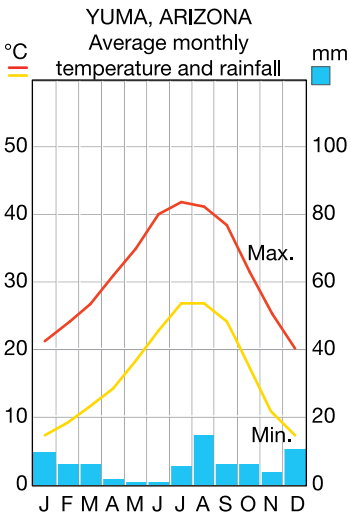
4.3.6 Desert climate

Temperature

One geographical characteristic of many deserts is the high temperature, which quickly evaporates any water that might be around. The Earth's highest recorded temperature — 58 °C — occurred at El Azizi in the Libyan Desert of northern Africa on 13 September 1922.

During the summer of 1923–24, the semi-arid town of Marble Bar in Western Australia (average rainfall 361 mm per year) experienced temperatures of more than 37.8 °C for 160 days in a row, from 31 October 1923 to 7 April 1924. This set an Australian temperature record, and possibly a world record. During that summer the temperature at Marble Bar peaked at 47.5 °C on 18 January 1924.

FIGURE 9 Temperature and rainfall data can be displayed clearly in a climograph, such as this one for Yuma, Arizona.



Rainfall

Although low rainfall is a characteristic of deserts, rain does fall and violent storms can sometimes occur. A record 44 millimetres of rain once fell within three hours in the Sahara. Large Saharan storms may deliver up to one millimetre of rain per minute. Normally dry stream channels, called arroyos or wadis, can quickly fill after heavy rains, and flash floods make these channels dangerous.

Monthly data for rainfall and temperature can be used to create climographs such as figure 9. Data for other desert locations such as Khormaksar in Yemen and Alice Springs in Australia (see table 1) can be used to construct climographs.

TABLE 1 Climate data for (a) Khormaksar, Yemen, and (b) Alice Springs, Australia

(a) Khormaksar, Yemen

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average temperature (°C)	25.0	25.5	27.0	28.5	30.5	33.0	32.0	32.0	32.0	28.5	26.5	25.5	
Average rainfall (mm)	5.0	0.0	5.0	0.0	0.0	0.0	5.0	3.0	0.0	0.0	0.0	5.0	23.0

(b) Alice Springs, Australia

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average temperature (°C)	28.5	27.7	24.8	20.0	15.4	12.4	11.5	14.3	18.3	22.8	25.8	27.7	
Average rainfall (mm)	40.5	41.5	34.7	16.6	17.0	16.7	12.1	10.0	9.0	20.0	25.3	37.2	281.2

eBook*plus*

Interactivity
Climate graph: Timbuktu
Use this interactivity to build a climate graph for Timbuktu, in the Sahara Desert.
Searchlight ID: int-0780

Weblink
Desert rain

ACTIVITIES

IDENTIFY

1 Decide whether the following statements are true or false. Rewrite the false statements to make them true.
- **a** The cooler the air, the more moisture it can hold.
- **b** Rain shadows often contain dry areas of land.
- **c** Cold ocean currents cool the air above them.
- **d** Deserts do not form along coastlines.

EXPLAIN

2 Use figure 1 to explain why deserts form around areas near the tropics but not at the equator. Alternatively, form small groups and create a short drama performance to explain the process.

3 Use figure 3 and any other information in this section to write a paragraph explaining why deserts tend to form in rain shadows. Alternatively, form small groups and create a short drama performance to explain the process.

4 Why do temperatures in deserts drop so much at night after being so high during the day?

INVESTIGATE

5 Use the **Desert rain** weblink in your eBookPLUS to watch a video about desert rain, and then answer the following questions.
- **a** What is a flash flood?
- **b** What happens to water as it flows over sand? Think of what happens to water at the beach.
- **c** How do animals and plants respond to these rare water events?
- **d** Describe how the landscape quickly ***changes*** once there is water in the desert.

APPLY

6 Draw a diagram to explain how cold ocean currents influence the formation of a desert ***environment*** along the south-west African coastline.

7 Complete the **Climate graph: Timbuktu** interactivity in your eBookPLUS, and then use tables 1a and 1b to draw climate graphs for Khormaksar, Yemen, and Alice Springs, Australia.

4.4 What are the processes that shape desert landforms?

4.4.1 Shaping the desert

Although most people imagine a sea of sand when they think of deserts, sand covers only about 20 per cent of the world's deserts. Sand is the end product of millions of years of **erosion** of other landforms such as rock and plateaus that, over time, are worn away by extremes of temperature, wind and water.

erosion the wearing away and removal of soil and rock by natural elements, such as wind, waves, rivers or ice, and by human activity

The landforms and patterns of a desert are created by a number of natural processes. The unprotected land surfaces are prone to erosion. After heavy rain, often a long distance from the desert flood plains, erosion of ancient river channels can be major. Extreme temperatures, along with strong winds and the rushing water that can follow a desert rainstorm, cause rocks to crack and break down into smaller fragments. This process is called **weathering**.

weathering the breaking down of rocks through the action of wind and water and the effects of climate

Erosional landforms

The process of erosion removes material such as weathered rock. Most erosion in deserts is caused by wind and, at times, running water. During heavy rainfall, water carves channels in the ground. Fast-flowing water can carry rocks and sand, which help to scour the sides of the channel. As vegetation is usually sparse or non-existent, there are few roots to hold the soil together. Eventually, deep gullies called wadis can form.

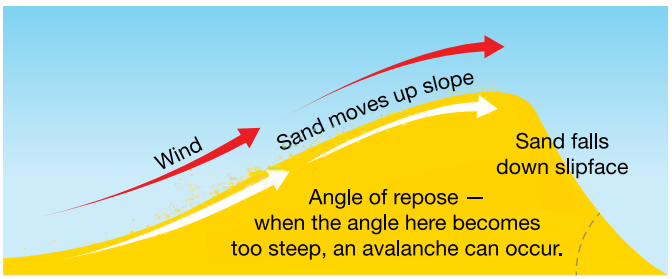
Erosion can also result from the action of wind and from chemical reactions. Some rock types, such as limestone, contain compounds that react with rainwater and then dissolve in it. Wind is a very important agent of transport and deposition, and can change the shape of land by abrasion — the wearing down of surfaces by the grinding and sandblasting action of windborne particles. Erosional landforms in deserts include buttes, mesas and inselbergs (see figure 7).

Depositional landforms

Materials carried along by rushing water and wind must eventually be put down. Over time these materials build up, forming different shapes and patterns in the desert. This process is called deposition.

Depositional landforms in deserts include alluvial fans, playas, saltpans and various types of sand dunes (see figure 7).

FIGURE 1 The transport and deposition of sand creates and moves dunes.



4.4.2 Sand dunes

Different dune shapes are created by the action of the wind. These include crescent, linear, star, dome and parabolic. The most common are the crescent-shaped dunes that are formed when the wind blows in one direction. They are usually wider than they are long and can move very quickly across desert landscapes (see figure 2).

FIGURE 2 A series of crescent dunes in Egypt



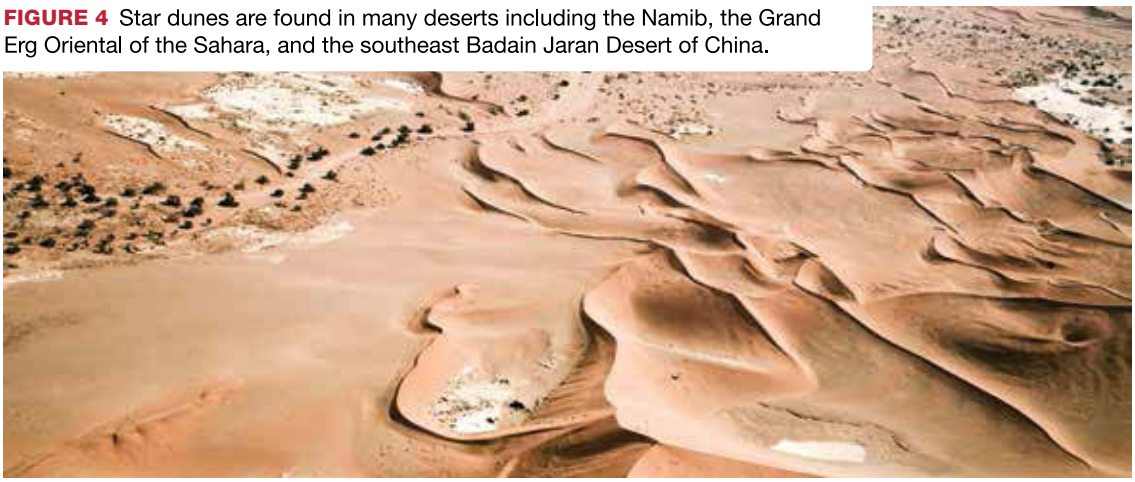
Linear dunes are a series of dunes running parallel to each other. They can vary in length from a few metres to over 100 kilometres. It appears that winds blowing in opposite directions help create these dunes. The Simpson Desert in central Australia has linear dunes (see figure 3).

FIGURE 3 Linear sand dunes in the Simpson Desert, Australia



Star dunes have 'arms' that radiate from a high central pyramid-shaped mound. They form in regions that have winds blowing in many different directions and can become very tall rather than wide — some are up to 500 metres high (see figure 4).

FIGURE 4 Star dunes are found in many deserts including the Namib, the Grand Erg Oriental of the Sahara, and the southeast Badain Jaran Desert of China.



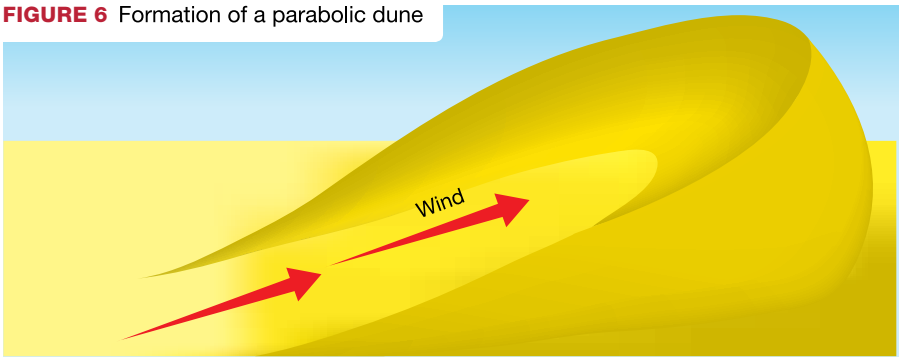
Dome dunes are made up of fine sand without a steep side. These rounded structures tend to be only one or two metres high and are very rare (see figure 5).

FIGURE 5 A dome dune in the Chihuahuan Desert, North America



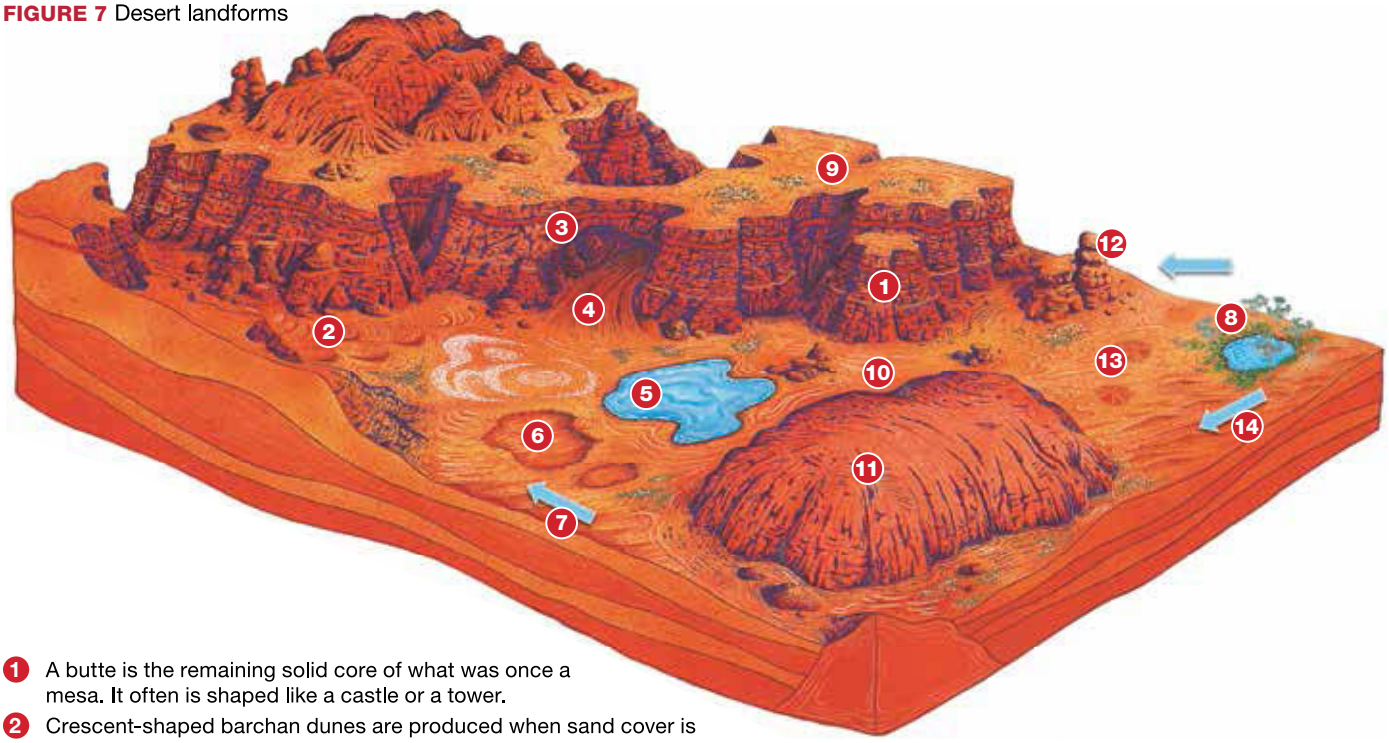
Parabolic dunes have a U shape and do not get very high. They often occur in coastal deserts. The longer section follows the 'head' of the dune (the opposite process to the formation of crescent dunes) because vegetation has anchored them in place. The arms can be long — in one case, measured at 12 kilometres (see figure 6).

FIGURE 6 Formation of a parabolic dune



4.4.3 Desert landforms

FIGURE 7 Desert landforms



1. A butte is the remaining solid core of what was once a mesa. It often is shaped like a castle or a tower.
2. Crescent-shaped barchan dunes are produced when sand cover is fairly light.
3. An arch, or window, is an opening in a rocky wall that has been carved out over millions of years by erosion.
4. An alluvial fan is the semicircular build-up of material that collects at the base of slopes and at the end of wadis after being deposited there by water and wind.
5. A playa lake may cover a wide area, but it is never deep. Most water in it evaporates, leaving a layer of salt on the surface. These salt-covered stretches are called saltpans.
6. Clay pans are low-lying sections of ground that may remain wet and muddy for some time.
7. The rippled surface on transverse dunes is the result of a gentle breeze blowing in the one direction.
8. An oasis is a fertile spot in a desert. It receives water from underground supplies.
9. A mesa is a plateau-like section of higher land with a flat top and steep sides. The flat surface was once the ground level, before weathering and erosion took their toll.
10. Sand dunes often start as small mounds of sand that collect around an object such as a rock. As they grow larger, they are moved and shaped by wind.
11. An inselberg is a solid rock formation that was once below ground level. As the softer land around it erodes, it becomes more and more prominent. Uluru is an inselberg.
12. A chimney rock is the pillar-like remains of a butte.
13. Star dunes are produced by wind gusts that swirl in from all directions.
14. Strong winds blowing in one direction form longitudinal dunes.

Playas and pans

A desert basin may fill with water after heavy rains to form a shallow lake, but for the majority of the time the often salt-encrusted surface is hard and dry. Such expanses of land are known as playas, saltpans or hardpans. The flat terrains of pans and playas make them excellent race tracks

and natural runways for aeroplanes and spacecraft. Ground-vehicle speed records are commonly established on Bonneville Speedway, a race track on the Great Salt Lake hardpan. Space shuttles land on Rogers Lake Playa at Edwards Air Force Base, California.

FIGURE 8 A driver lying in a streamlined racing car, Bonneville Salt Flats, Utah, USA



ACTIVITIES

IDENTIFY

1 List the agents of erosion and weathering in a desert.
2 Name two erosional and two depositional landforms in a desert.
3 Name the most common dune shapes that are formed in deserts.

EXPLAIN

4 Explain the difference between a mesa and a butte.
5 How does vegetation help to prevent erosion in a desert?
6 What wind conditions are needed to create a:
  a star dune
  b longitudinal dune
  c parallel dune?
7 Why do you think oases are such fertile places?
8 What do chimney rocks and arches have in common?
9 What do playa lakes and saltpans have in common?
10 Draw up and complete a table like the one below for the three landforms listed. Continue to add the landforms shown in figure 7 to your table. Add examples of other desert landforms that you have found when researching this topic.

INVESTIGATE

11 Locate all the desert ***places*** named in this section. Use Google Maps to create your own world map of these locations, adding interesting facts and some images of each location. Email a link to your completed map to your teacher.

PREDICT

12 Study the landforms labelled 1, 3 and 9 in figure 7. Sketch what each of these may look like in the future as erosion and weathering continue to occur.

APPLY

13 Work in small groups to create a model of a desert (using plasticine or playdoh, for example) that contains a number of desert forms and patterns. Use figure 7 as a guide. Show your completed model to the other groups, providing and responding to constructive feedback.

Name of landform	Picture of landform	Location	Type of erosion (wind or water)	Type of deposition (wind or water)
Butte				
Mesa				
Inselberg				

4.5 What are the characteristics of Australia's deserts?

4.5.1 The location of Australia's deserts

Australia is the world's driest inhabited continent. Over 70 per cent of the country receives between 100 and 350 millimetres of rainfall annually, which makes most of Australia arid or semi-arid.

Australia's deserts are sub-tropical and are located mainly in central and western Australia, making up about 18 per cent of the country (see figure 1). They are hot deserts, which mean that they are areas of little rainfall and extreme temperatures — rainfall can be less than 250 millimetres per year, and temperatures can rise to over 50 °C. The average humidity (moisture in the air) is between 10 and 20 per cent. The desert terrain is very diverse and can range from red sand dunes to the polished stones of the gibber plains — the term *gibber* comes from an Aboriginal word for stone.

Great Victoria Desert

The Great Victoria Desert, Australia's largest, covers 424 400 square kilometres. It is not a desert of dunes, but has some desert-adapted plants including marble gums, mulga and spinifex grass. Part of this desert has been named a Biosphere Reserve by UNESCO and is one of the largest arid zone biospheres in the world.

The Great Sandy Desert

The Great Sandy Desert makes up 3.5 per cent of Australia. The red sands of this desert reach almost to the Western Australia coast, where they join with the white sand of Eighty Mile Beach south of Broome.

Simpson Desert

The Simpson Desert is in one of the driest areas of Australia, with rainfall of less than 125 millimetres per year. It is located near the geographical centre of Australia. Dunes (see figure 2) make up nearly three-quarters of the desert. Long parallel dunes (see figure 3 in section 3.3) form in a north–north-west/south–south-east direction; some can be straight and unbroken for up to 300 kilometres and can be 40 metres high. The space between the dunes can vary from 100 metres to 1000 metres.

Strzelecki Desert

This desert is located within three states — far northern South Australia, south-west Queensland and western New South Wales. The dunes support vegetation such as sandhill wattle, needlebush and hard spinifex.

Tanami Desert

Located to the east of the Great Sandy Desert, this desert is mostly characterised by red sand plains with hills and ranges.

Little Sandy Desert

The Little Sandy Desert is located in Western Australia and borders three other deserts. Its landforms are similar to those in the Great Sandy Desert. It includes a vast salt lake called Lake Disappointment.

FIGURE 1 The location and distribution of Australia's deserts



Source: Spatial Vision

FIGURE 2 Sand dunes and vegetation in the Simpson Desert



FIGURE 3 Gibber landscape in the Sturt Stony Desert in South Australia



FIGURE 4 Desert between Oodnadatta and William Creek, South Australia



Sturt Stony Desert

The Sturt Stony Desert, located in north-eastern South Australia, is a harsh gibber desert covered in closely spaced glazed stones. These are left behind when the wind blows away the loose sand between the dense covering of pebbles. The desert also contains some dunes and hills that are resistant to weathering.

Tirari Desert

This small desert covers almost 1600 square kilometres and is located in far northern South Australia, east of Lake Eyre. It contains many linear (parallel) dunes and salt lakes. Cooper Creek runs through the centre of the desert, as do many other **intermittent creeks**. Where there is enough water — usually in waterholes — river red gums and coolabah gums will grow. Tall, open shrubland also occurs in some areas.

Gibson Desert

The fifth largest in Australia, the Gibson Desert is located in Western Australia and borders three other deserts. It consists of sand plains and dunes plus some low, rocky ridges. Some small salt-water lakes are also present in the south-western part of the desert.

Pedirka Desert

The Pedirka Desert in South Australia is Australia's smallest desert, located north-east of Oodnadatta (see figure 4). The lines of parallel red dunes run north-east to south-west, and the space between the dunes can be up to one kilometre. Hamilton Creek is located in this desert and its banks are home to river red gums, coolabah, mulga, prickly wattle and dead finish.

intermittent creeks a creek that flows for only part of the year following rainfall

FOCUS ON FIELDWORK

Investigating the diversity of vegetation in the school grounds

The extent of vegetation varies depending on temperatures and rainfall. In desert areas, vegetation is often limited due to harsh climatic conditions. Collect data on the vegetation diversity around your school grounds to compare them to a desert area. Complete the following activities to help collect data. Use SkillBuilders in your eBookPLUS to help you.

- Construct a sketch map of areas of vegetation around the school.
- Annotate the sketch maps to describe and identify the vegetation found.
- Photograph the vegetation areas around the school at different times of the year.

1. How does the temperature and rainfall data that you collected earlier help to explain the diversity and type of vegetation around the school?
2. Is there any vegetation present that can thrive in desert-like conditions?
3. What would happen to the vegetation in your school area if less rainfall and extreme temperatures were experienced?

FIGURE 5 Examining information and recording data in the field



ACTIVITIES

IDENTIFY

1 Name the deserts bordered by:
   a the Gibson Desert
   b the Little Sandy Desert.
2 What is a gibber desert?
3 What percentage of Australia is arid or semi-arid?

EXPLAIN

4 Look at figure 1 showing the distribution of Australia's deserts. Describe their location in terms of the tropics.

INVESTIGATE

5 Several plants are listed in the descriptions in this section of Australia's deserts. Choose two different plant types (for example a grass and a tree) and conduct research to find out how they are adapted to desert conditions.
6 Conduct some research to find out the characteristics of the Biosphere Reserve declared by UNESCO located in the Great Victorian Desert.
7 Use an atlas to find the locations of Brisbane, Geraldton and Exmouth. These are located at the same latitude as many of Australia's deserts. Use the **BOM** weblink in your eBookPLUS to find the average temperature, rainfall and humidity of these places.
   a How do these characteristics compare with the temperature, rainfall and humidity in Australia's deserts?
   b How can you account for the differences?

eBookplus

Weblink
BOM

4.6 How did Lake Mungo become dry?

4.6.1 Where are Lake Mungo and the Willandra Lakes located?

Lake Mungo, in Mungo National Park, is just one of 13 ancient dry lake beds in a section of the Willandra Lakes Region World Heritage area in semi-arid New South Wales. There is no water there now, yet the lakes were once full of water and teeming with life, supporting Aboriginal people for more than 47 000 years — archaeological records show this continuous human presence. What happened to change this environment into the semi-arid landscape it is today?

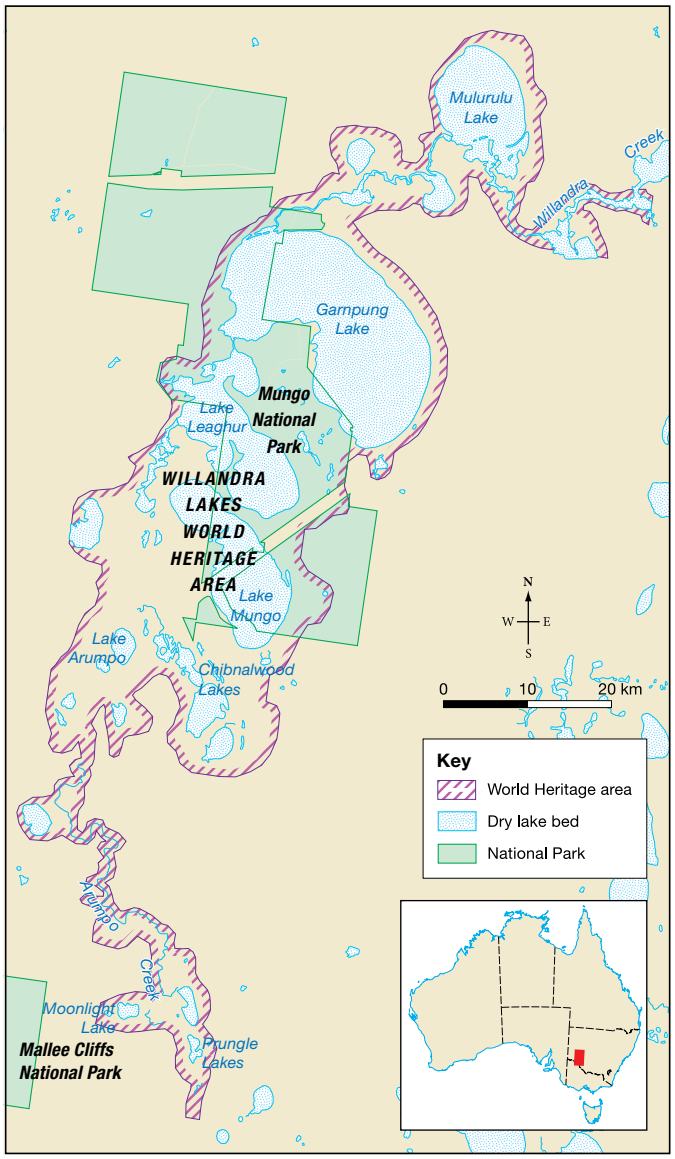
The Willandra Lakes are located in far south-western New South Wales and the region is part of the Murray–Darling River Basin. Lake Mungo is 110 kilometres north-east of Mildura, Victoria. The lakes were originally fed by water from Willandra Creek (see figure 1), which was a branch of the Lachlan River. The average rainfall in this area is 325 millimetres per year, making it a semi-arid desert region.

How has Mungo changed over time?

40 000 years ago

During the last ice age, huge amounts of water filled the shallow lake. At its fullest, Lake Mungo was 6–8 metres deep and covered 130 square kilometres (more than twice the area of Sydney Harbour). The lakes were rich with life, including water birds, freshwater mussels, yabbies, and fish such as golden perch and Murray Cod. Giant kangaroos, giant wombats, large emus and the buffalo-sized Zygomaturus — all now extinct — grazed around the water's edge. Remains of more than 55 species have been found in the area and identified — 40 of these are no longer found in the region, and 11 are extinct.

FIGURE 1 Location of the Willandra Lakes, including Lake Mungo



Source: Spatial Vision

Aboriginal people lived here in large numbers — evidence for this has been found in more than 150 human fossils, including 'Mungo Lady' discovered in 1968 and 'Mungo Man' in 1974, both believed to be over 40 000 years old. The youngest fossil is 150 years old.

30 000–19 000 years ago

A west wind blows across this landscape. During low-water years, red dust and clay was blown across the plains to the eastern side of the lake and mixed with sand dunes on the edge of the lake (formed when the lake was full; see figure 3). This began the formation of lunettes (crescent-shaped dunes) on the east side — called 'the Walls of China' in Lake Mungo. Vegetation covered the dunes, protecting them.

FIGURE 2 Traditional owners clean fossilised footprints at Lake Mungo.



19 000 years ago

The lakes were full of deep, relatively fresh water for a period of 30 000 years — with cycles of wet and dry occurring — which came to an end 19 000 years ago when the climate became drier and warmer. Eventually, the water stopped flowing into the lake system and it dried out (see figure 4).

FIGURE 3 The process of erosion while Lake Mungo was full

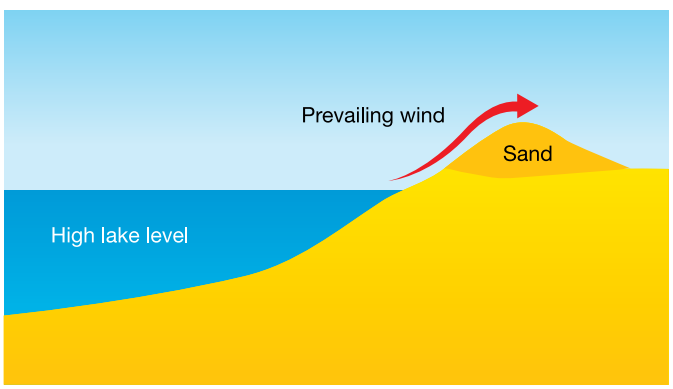
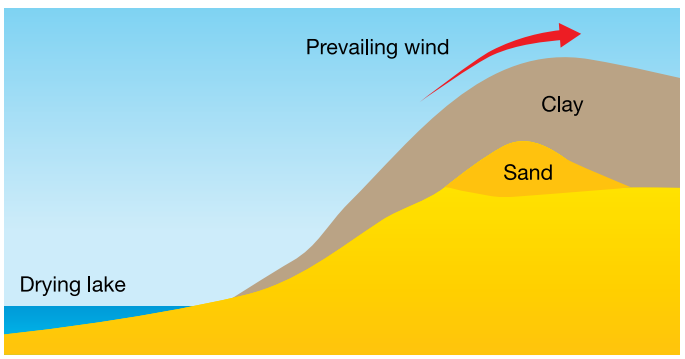


FIGURE 4 The process of erosion while Lake Mungo was drying out



Present day

Today, the lake beds are flat plains covered by low saltbush and bluebush as well as grasses. Grazing cattle and sheep (now no longer allowed in the national park) and rabbits have caused erosion of the lunettes and sand dunes, exposing the human and animal fossils that have since been discovered (see figure 5).

FIGURE 5 The 'Walls of China' at Lake Mungo. The dry lake bed is covered by low bushes and grasses.



4.6.2 World Heritage listing

The Willandra Lakes Region, which includes Lake Mungo, is listed as a World Heritage Area. This region is important because of its archaeology and geomorphology. Human skeletons, tools, shell middens and animal bones found here make up the oldest evidence of burial places in the world. The ancient and undisturbed landforms and sediments provide rich information about the geomorphological processes that created this environment.

eBookplus

Interactivity
Evolving Lake Mungo
Use this interactivity to examine how Lake Mungo has changed over time.
Searchlight ID: int-3108

ACTIVITIES

IDENTIFY

1 What makes Lake Mungo and the Willandra Lakes region a semi-desert?
2 When did Lake Mungo dry up?
3 What is a lunette?

EXPLAIN

4 Describe how the lunettes formed over time.
5 Outline the evidence that shows that many Aboriginal people lived in this area.
6 What human activity caused the lunettes to erode? What did the erosion unearth?
7 Find out what World Heritage listing means in terms of protecting this ***place***. Why is it important?

INVESTIGATE

8 Work in small groups to create an identification brochure with pictures and facts about these three extinct animals that once lived at Lake Mungo.
- *Genyornis newtoni* (giant emu)
- *Protemnodon goliah* (giant short-faced kangaroo)
- *Zygomaturus trilobus* (Zygomaturus)

9 Use the **Timetoast** weblink in your eBookPLUS, the information in this subtopic and images you find through online research to create your own colourful electronic timeline of the changes that occurred at Lake Mungo.

eBookplus

Weblink
Timetoast

4.7 How do people use deserts?

4.7.1 Traditional livelihoods

Although not many people live in deserts, these environments have been important to traditional communities for many years. People either adapt to living in deserts or transform deserts to suit their needs. People are also attracted to desert regions to mine resources.

There are many traditional communities who live in deserts including the Australian Aborigines; the Bedouin of the Middle East and Sahara; the Tuareg of the Sahara in North Africa; the Topnaar in the Namib Desert and the Bushmen of the Kalahari in southern Africa (see figure 1); the Timbisha Shoshone of the Mohave Desert in the USA; and the communities from the Atacama Desert in South America.

FIGURE 1 Bushmen of the Kalahari



nomadic describes a group or tribes that move from place to place depending on the food supply

Many of these communities are **nomadic** and live traditional lives, moving with the seasons and obtaining all their needs from the land or herding animals and trading with people in settlements. It is important to understand that not all desert people are traditional desert-dwellers. For example, many Australian Aboriginal groups do not live in deserts and do not practise traditional ways.

In some deserts the traditional ways have changed as greater contact has been made with settlements, with many previously nomadic groups now choosing to live in settlements.

4.7.2 Desert resources

Many of the changes in deserts have been brought about by developments in technology. These changes have resulted in water being extracted and used to grow crops, and minerals being mined and used in many ways.

Water in the desert

Drilling equipment and pumps have allowed deep bores to tap into groundwater in aquifers deep below the desert surface. This has transformed some deserts in northern Africa and the Middle East into a series of circular irrigation fields — some of these can be up to three kilometres in diameter. In Australia, groundwater from the Great Artesian Basin has enabled desert communities to exist and grazing to take place. Unfortunately, the groundwater in many areas is being pumped out far more quickly than it is being replaced and may be in danger of running out.

Desalination plants have also provided water to desert communities in many areas, especially the Middle East, including large cities such as Dubai.

FIGURE 2 (a) Satellite image of circular irrigation fields in Saudi Arabia; (b) aerial photograph of a circular irrigation field



Mining in deserts

Many deserts contain valuable mineral deposits that were formed in the arid environment or have been exposed by erosion. Desert mining has created a lot of wealth for some people and companies, but usually not for the traditional desert people.

Examples of mining resources include:

- iron and lead-zinc ore — mined in Australian deserts
- phosphorus (used to make fertilisers) — mined in the Sahara region
- borates (used to manufacture glass, ceramics, enamels and agricultural chemicals) mined in the deserts of California, United States
- copper, iron ore and nitrates — mined in Chile's Atacama Desert
- precious metals such as gold, silver and platinum — mined in the deserts of Australia, America and central Asia
- uranium — mined in Australia and the United States
- diamonds — mined in the Kalahari and Namib deserts of south-western Africa
- oil — more than 65 per cent of the world's oil is found in the desert regions of the Middle East, mainly in Kuwait, Iraq, Iran and Saudi Arabia.

FIGURE 3 A uranium mine next to the Colorado River in the United States



ACTIVITIES

IDENTIFY

1 List the sources of water in a desert that can be used to grow crops and provide water for people.

2 How has technology enabled water to be used in deserts?

EXPLAIN

3 Explain how most desert people adapt to live in the desert ***environment***, or adapt the ***environment*** to live in the desert? Give two examples to support your reasoning.

4 Why is it important to use groundwater ***sustainably***?

5 Mining companies generally receive the wealth from mining. Why do you think that the traditional desert communities miss out? Should they receive some of the benefits of mining? How could the profits be distributed more evenly?

INVESTIGATE

6 Investigate one of the desert communities mentioned in this section. Conduct research to identify where these communities generally live, and find examples of their traditional ways of life including living conditions and shelter. Present your information in an interesting way, such as a Prezi, Keynote or PowerPoint presentation, and use images and maps where possible.

PREDICT

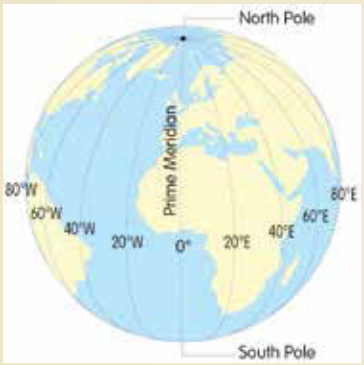
7 Make a sketch of figure 3. Label your sketch to include the river, the mine site and the buildings. How has mining ***changed*** this ***environment***? What issues could arise due to the location of this mine? Predict what might happen to this area when mining stops.

eBookplus ONLINE ONLY

4.8 SkillBuilder: Using latitude and longitude

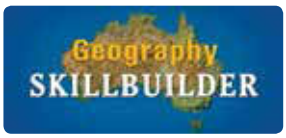
What are latitude and longitude?

Latitude and longitude are imaginary grid lines encircling the Earth. The lines that run parallel to the equator are called parallels of latitude and are measured in degrees. Lines of longitude run from north to south from the North Pole to the South Pole. These are called meridians of longitude and are also measured in degrees. Lines of latitude and longitude are drawn on maps to help us locate places.



eLesson

Watch the video to learn how to use latitude and longitude.



Searchlight ID: eles-1652

Interactivity

Try this interactivity to learn how to use latitude and longitude.



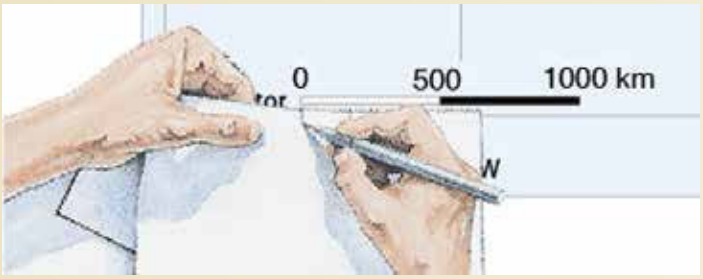
Searchlight ID: int-3148

eBookplus ONLINE ONLY

4.9 SkillBuilder: Calculating distance using scale

What does it mean to calculate distance using scale?

Calculating distance using scale involves working out the actual distance from one place to another using a map. The scale on a map allows you to convert distance on a map or photograph to distance in the real world. A linear scale is the easiest to use.



eLesson

Watch this video to learn how to calculate distance using scale.



Searchlight ID: eles-1653

Interactivity

Try this interactivity to learn how to calculate distance using scale.



Searchlight ID: int-3149

4.10 How do people manage deserts?

4.10.1 Sahara: a desert on the move

Many people around the world use deserts to live in, to mine for resources or to use for agricultural purposes. All of these things have an impact on desert areas and they need to be managed.

FIGURE 1 Sand taking over in Nouakchott



Nouakchott, the capital city of Mauritania in West Africa, is slowly being engulfed by the Sahara Desert. Years of continuous drought, deforestation and poor farming methods have all contributed to the **desertification** being experienced. The Mauritanian government has planted vegetation to act as a barrier to the encroaching sand; however, not all of these **greenbelts** have worked due to poor management. Current projects include expanding the greenbelts with a variety of different plant species and to manage the population growth of Nouakchott to avoid moving into the desert areas.

desertification the process by which an area becomes a desert

greenbelts plantations of trees for the purpose of conservation

GEOskills TOOLBOX

Using scale to measure distance on a map

We can use the scale on a map to measure the distance between two points. If the distance is in a straight line, we can use a ruler. If you need to measure something that is not in a straight line, such as a river or a coastline, you can use a piece of string and then measure that length of string on a ruler.

ACTIVITIES

IDENTIFY

1. Explain how desertification is affecting Nouakchott.
2. Refer to the topographic map of Nouakchott to answer the following.
   - a What landform features are shown on the map?
   - b What is the area reference of the city of Nouakchott?
   - c Using the scale, how far away is Nouakchott from the coastline?
   - d How close are the sand and the dunes to the built-up areas?

PREDICT

3. What impact could the sand dunes have on the wells?
4. What impact could the sand have on the roads?

APPLY

5. Describe how the map confirms that desertification is a problem in Nouakchott.
6. Write a proposal to the Mauritanian government suggesting where greenbelts should be placed. Include the area reference of where your greenbelts will go and what they will help to protect. Refer to the writing task in your eBookPLUS for information on how to respond to this question.

eBookplus ONLINE ONLY

4.11 Is Antarctica a desert?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au.**

eBookplus ONLINE ONLY

4.12 How do people use Antarctica?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au.**

FIGURE 2 Topographic map of Nouakchott, Mauritania



eBook*plus* ONLINE ONLY

4.13 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au.**

4.8 SkillBuilder: Using latitude and longitude

4.8.1 Tell me

What are latitude and longitude?

Latitude and longitude are imaginary grid lines encircling the Earth. They can be drawn over a map to help us locate a place.

The lines that run parallel to the equator are called **parallels of latitude**. Each line is measured in degrees north (N) and south (S) of the equator (0°). The equator divides the Earth into two parts — the northern hemisphere and the southern hemisphere. The latitude at the North Pole is 90°N, and the latitude at the South Pole is 90°S. All places have a latitude reading somewhere between 0° and 90°N, or 0° and 90°S.

Lines of longitude run from north to south from the North Pole to the South Pole. These are called **meridians of longitude** and are also measured in degrees. The Prime (or Greenwich) Meridian (0°) runs through Greenwich Observatory near London, England. Places are either east (E) or west (W) of this line. All places have a longitude reading somewhere between 0° and 180°E, or 0° and 180°W.

FIGURE 1 The parallels of latitude

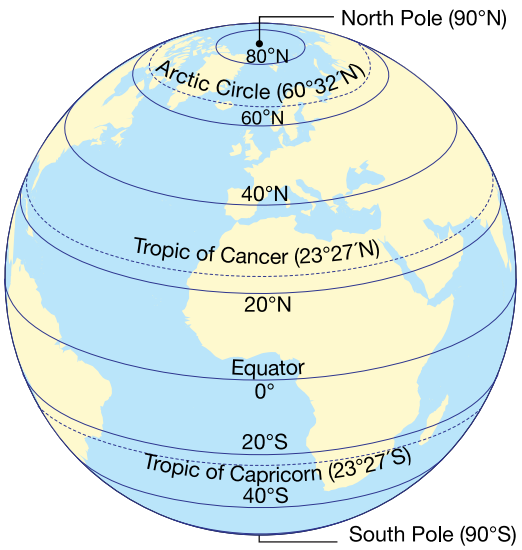
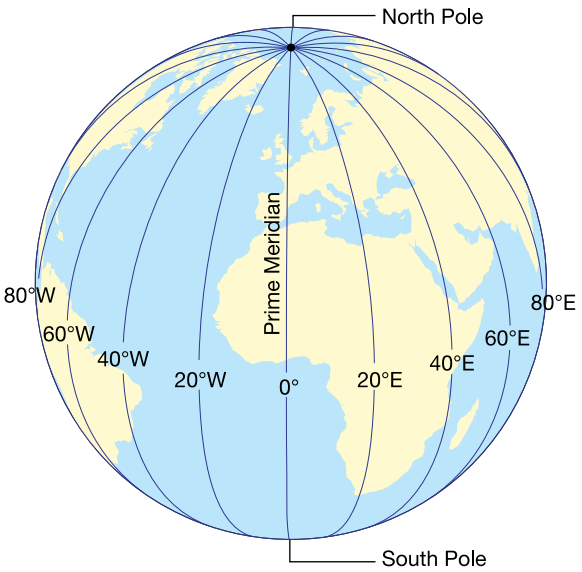


FIGURE 2 The meridians of longitude



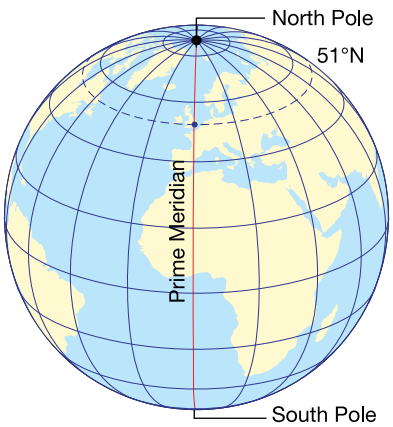
Why are latitude and longitude useful?

Latitude and longitude are used to give the precise location of a place in an atlas, on a globe, or on a map showing a large region. Lines of latitude and longitude form a grid pattern on a map and this makes identifying the location of a place easy. For example, Philadelphia in the United States can be found at 40°N 75°W. A gazetteer index lists latitude and longitude readings of all places featured in an atlas.

Latitude and longitude are useful for identifying exact locations when, for example:

- sailing on the open ocean
- flying across vast expanses
- gaining a GPS reading
- viewing Google Earth
- studying maps to plan a touring holiday.

FIGURE 3 Latitude and longitude lines form a grid pattern.



Model

FIGURE 4 North and Central America



Source: Spatial Vision

Philadelphia in the United States is located at 40°00'N 75°10'W. Further east, on the coast, is Boston at 42°20'N 71°05'W. Dallas in the central south of the country is at 32°47'N 96°48'W. On the west coast, Los Angeles is at 34°00'N 118°15'W and San Francisco is at 37°45'N 122°27'W.

Using latitude and longitude accurately involves:

- identifying the precise location of a place
- accurately reading meridians of longitude
- accurately reading parallels of latitude
- writing the reading correctly.

4.8.2 Show me

How to use latitude and longitude

You will need:

- a map with a latitude and longitude grid
- a ruler.

eBookplus

eLesson
Using latitude and longitude
Searchlight ID: eles-1652

Procedure:

To give the latitude and longitude readings of a location, complete the following steps.

STEP 1

Determine the place for which you want to give a latitude and longitude reading.

STEP 2

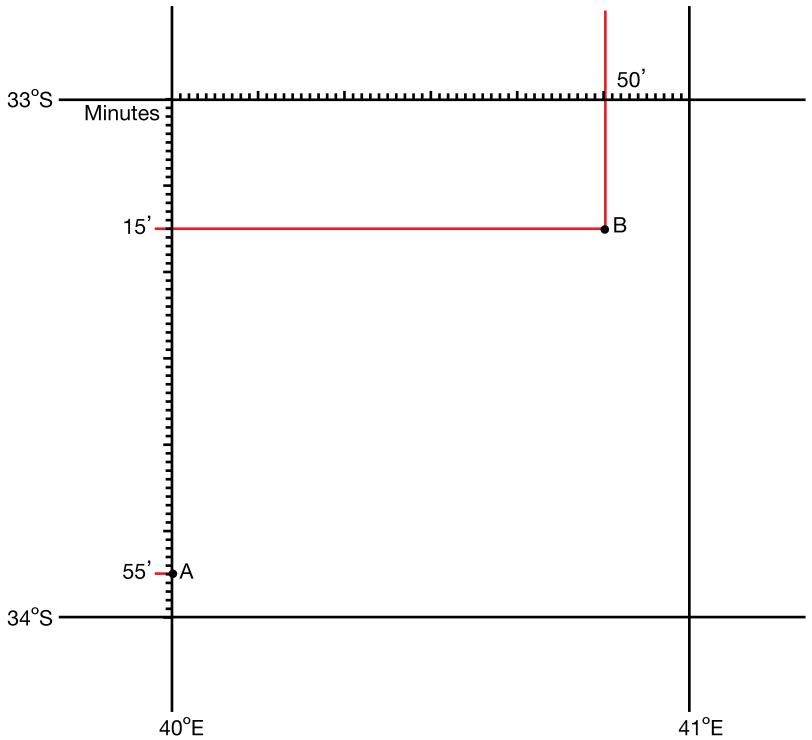
Begin with the parallels of latitude. Determine the degrees on the line closest to the location. For example, in figure 4 Philadelphia is at 40°N — it is exactly on the line of latitude and north of the equator. The equator (0°) is not shown in figure 4 but can be assumed to be off the bottom of the map, given the latitude readings on the right-hand side of the map. Not all parallels of latitude are drawn on a map and so you will often have to work out what the closest line of latitude is. In figure 4, Dallas is at 33°N.

You may have noticed in figure 4 that an additional parallel of latitude has been drawn and labelled the Tropic of Cancer. This line is at 23.5°N. A similar line is found at 23.5°S and is known as the Tropic of Capricorn. It passes through northern Australia just near Rockhampton. It is between these two lines that the sun moves and determines our seasons.

STEP 3

Each degree on the grid is made up of 60 minutes. It is likely that a place is not situated exactly on the degree line, so you will need to determine a minute reading as well. This becomes especially evident in smaller-scaled maps. Calculate the minutes for the place you are identifying. It is often a good idea to place a ruler on the map or use a finger to follow a line so that your eyes don't inadvertently cross to another grid square.

FIGURE 5 Showing minutes of a degree



STEP 4

Combine the readings to get a precise latitude for place. Place A in figure 5 is at 33°55'S. (The 'S' indicates that this place is south of the equator.)

STEP 5

Longitude is calculated in a similar manner. Find the north–south line (meridian) closest to the place. Take the line reading and then the degrees reading. For example, in figure 4 Philadelphia is at 75°W. The 'W' indicates it is west of the Prime Meridian. The Prime Meridian is not shown on figure 4 but the numbering on the meridians at both the top of the map and the bottom of the map indicate that the Prime Meridian is off the map to the right. On a more detailed map, a minute reading could also be obtained.

STEP 6

When combining the grid readings, latitude always comes first. A useful tip is to remember that 'latitude' comes before 'longitude' alphabetically. In figure 4, Philadelphia is at 40°N75°W. In figure 5, place B is at 33°15'S 40°50'E. Check that you can find these two places.

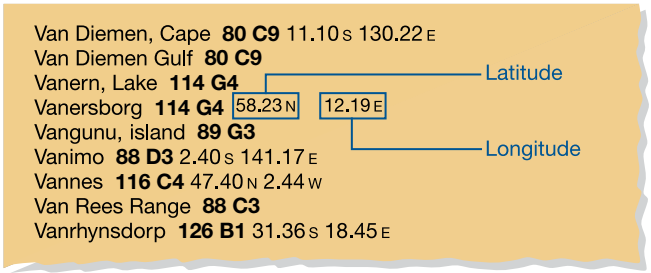
STEP 7

In the gazetteer index of an atlas, the reading for Philadelphia is listed as 40°00'N 75°10'W. Have a look in an atlas gazetteer index, usually in the back of the atlas, as the places are all identified by latitude and longitude. With a partner, test each other by naming and looking up locations on a map and practising giving their latitude and longitude.

eBook*plus*

Interactivity
Using latitude and longitude
Searchlight ID: int-3148

FIGURE 6 A sample from the gazetteer index of an atlas.



4.8.3 Let me do it

Developing my skills

Using figure 1 in subtopic 4.5, give the latitude and longitude readings at the centre of the listed deserts to complete the table below.

Desert	Latitude and longitude reading
Gibson	
Tanami	
Simpson	
Great Sandy	

Questions

1. Which desert can be found at 22°S 133°E?
2. This South Australian desert can be found at 29°S 141°E. What is its name?
3. Give a latitude and longitude reading such that a person would find themselves at Davenport Range.
4. If you were to travel the full length of the Great Dividing Range, at what latitude and longitude would you begin and finish?
5. Which range extends furthest east — Hamersley, Carnarvon or Robinson? Give the latitude and longitude reading at its most easterly point.

Checklist

I have:

- identified the precise location of a place
- accurately read parallels of latitude
- accurately read meridians of longitude
- written the readings correctly.

Skills questions

1. Parallels of latitude are used to show:
   a. all places at the same height above sea level
   b. places on a grid in relation to the equator
   c. places that have something in common
   d. places on a grid in relation to 0° longitude.
2. The Prime Meridian is the line that:
   a. is numbered 1
   b. is at 180° longitude
   c. runs through Greenwich, England
   d. helps determine latitude.
3. Why do you need to use a ruler or run your finger along the line of the grid?
4. What is a good way to recall the order in which the readings should be given?

4.9 SkillBuilder: Calculating distance using scale

4.9.1 Tell me

What does it mean to calculate distance using scale?

Calculating distance using scale involves working out the actual distance from one place to another using a map. The scale on a map allows you to convert distance on a map or photograph to distance in the real world — what it represents on Earth's surface. A linear scale is the easiest to use. Sometimes the distance being measured between places is not straight.

Why is calculating distance by using scale useful?

Calculating distance by using scale provides a spatial understanding of an area. If you go to an unfamiliar place for a holiday and the tourist map information does not have a scale, it is very difficult for you to know how far it is between places on the map and therefore how long it might take to walk or drive between them. Maps and photographs often show large areas of the Earth on a page. Many people use maps or photographs to gather information and need to understand the distances between places. Examples of people who calculate distance by using scale include:

- architects
- town planners
- engineers
- pilots
- farmers
- tourists.

Model

FIGURE 1 Desert areas inhabited by the Bedouin people



Source: MAPgraphics Pty Ltd, Brisbane

The linear scale of this map (figure 1) is shown in the lower left corner. The shaded Bedouin lands are seen in the key/legend. The Sahara Desert, where the Bedouin people live, is approximately 5250 kilometres from west to east and on average 1900 kilometres from north to south.

A good calculation of distance using scale involves:

- accurately converting a ruler measured distance on a map to an actual distance by using a linear scale.

eBookplus

eLesson
Calculating distance using scale
Searchlight ID: eles-1653

4.9.2 Show me

How to calculate distance using scale

You will need:

- a map or photograph with a linear scale
- a piece of paper with a straight side for marking places
- a light grey pencil
- a piece of string
- a pencil.

Procedure:

To calculate the distance between places or around places, it is easiest if you have a map or photograph which has a linear scale as shown in figure 1.

STEP 1

Determine the two places between which you want to know the distance. If it is a straight line distance between the two places — the distance 'as the crow flies' — then your paper edge must be long enough to go between these points. If not, and the distance is winding, then you will need to learn to bend your paper (jump to Step 4) or use a piece of string (jump to Step 8).

STEP 2

Place the straight edge of the piece of paper between the two places. Mark the two extremities of the distance on the edge. Label the place names at each end if working from a map.

STEP 3

Place this marked edge of paper onto the linear scale drawn on the map. One end of the markings must be at 0. Read off the distance on the scale. If the distance is longer than the scale bar on the map, mark your paper edge where the scale bar ends and move this new mark to 0, repeating as often as required. If you have to do this then you will need to add the distances together to find the total distance between the named places. Don't forget to add the unit of measurement (for example, metres or kilometres).

FIGURE 2 Measuring straight distances with a scale

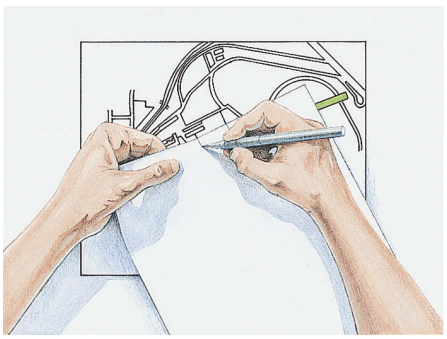
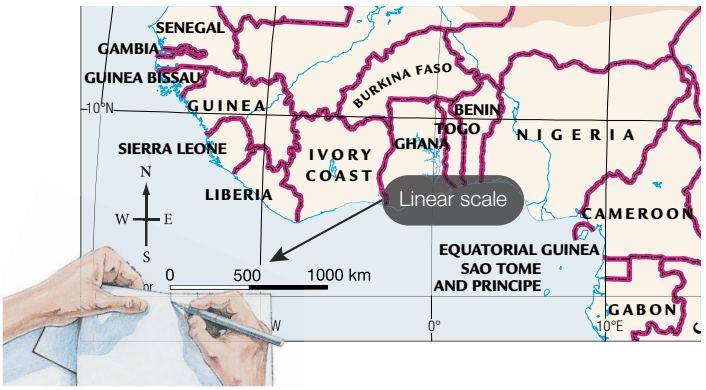


FIGURE 3 Converting the paper edge markings to a 'real' distance



STEP 4

If the distance is winding rather than straight — perhaps you are following a road through hills, or a river winding its way downstream, or a hiking track across a ridge — begin by placing the edge of the paper against the starting point, marking the edge with the place name.

STEP 5

Move the paper carefully so the edge follows the curve on the map. Use your pencil to apply light pressure while you adjust the paper edge to the curve.

STEP 6

Mark and label the end point on your paper.

STEP 7

Place the paper along the linear scale and read off the distance between your two places as you did in Step 3. Don't forget to add the unit of measurement (for example, metres or kilometres).

STEP 8

The technique using a piece of string is risky — if you let go of the piece of string, you'll have to start again! Place one end of the string at your starting point, and bend the string around the winding distance.

Mark the total distance carefully and place the string against the linear scale to calculate the total distance between the two places. One end of the string must be at 0. Read off the distance on the scale. If the distance is longer than the scale bar on the map, mark the string or hold it carefully where the scale bar ends and move this new mark to 0, repeating as often as required. If you have to do this, you will need to add the distances together to find the total distance between the named places. Don't forget to add the unit of measurement (for example, metres or kilometres).

FIGURE 4 Measuring curved distances with a scale using a paper edge

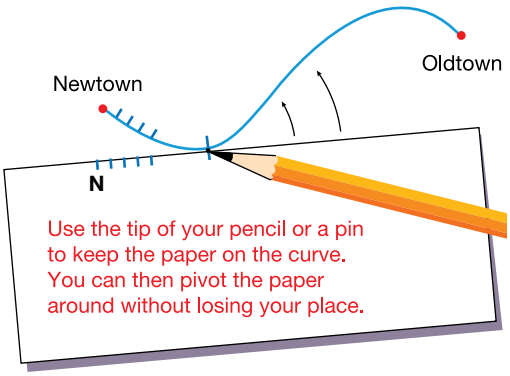
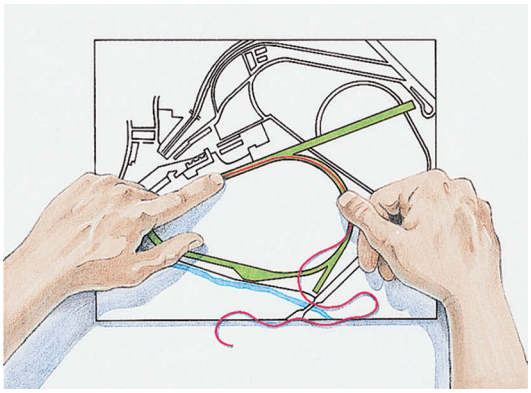


FIGURE 5 Measuring curved distances with a scale using a piece of string



4.9.3 Let me do it

Developing my skills

Using figure 1 in subtopic 4.5, complete the following.

Questions

1. How far is it from the west to the east of the Great Victoria Desert?
2. How far is it between the Central Desert and the Simpson Desert?
3. Calculate the distance around the Tanami Desert.
4. What is the distance around the area designated as 'arid zone'?
5. What length of 'arid zone' boundary is also on the coast of Australia?

eBook*plus*

Interactivity
Calculating distance using scale
Searchlight ID: int-3149

Checklist

I have:

- accurately converted a distance measured with a ruler on a map to an actual distance by using a linear scale.

Skills questions

1. Calculating distance using ***scale*** is used to show:
   a. the height of the land between places
   b. the shape of the land features
   c. how small areas can be drawn
   d. distance in the real world.
2. To find the length of a river on a map:
   a. find the distance between two places on the river
   b. draw a line along the river and measure its distance
   c. bend a page edge to fit the winding river, marking the distances
   d. guess the distance.
3. What is meant by the expression 'as the crow flies' when applied to distances on a map?
4. Why is it safer to use a piece of paper to move around a curve than to use a piece of string?

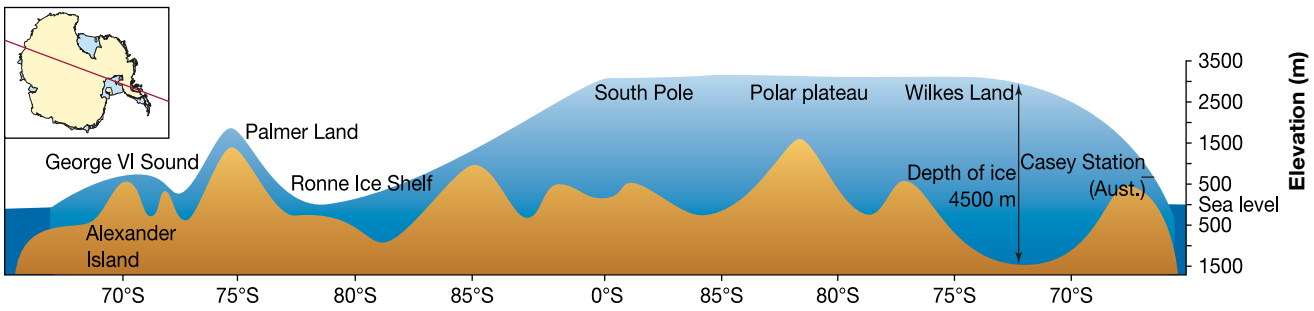
4.11 Is Antarctica a desert?

4.11.1 Some facts about Antarctica

Like hot deserts, polar deserts are areas with annual precipitation of less than 250 millimetres, but they have a mean temperature during the warmest month of less than 10 °C. Polar deserts are found in both the Arctic and Antarctic regions of the world. Not only is Antarctica a desert — it is also the driest, coldest and windiest continent on Earth.

Australia is the driest inhabited continent on Earth. However, Antarctica is even drier. Much of Australia's interior receives less than 250 millimetres of precipitation per year. The interior of Antarctica receives less than 50 millimetres. The coastal areas receive the highest levels of precipitation, but this is still only about 200 millimetres.

FIGURE 1 This cross-section, which shows the mountains below the ice, passes through some of the thickest parts of the Antarctic ice sheet.



Most of Antarctica is too cold for rainfall; the majority of the precipitation falls as snow. Some valleys in Antarctica have received no rain for two million years. It also snows very little in Antarctica, particularly in the interior.

In places, the ice sheet in Antarctica is 4.8 kilometres deep (see figure 1). Most of the ice that covers the continent has been there for thousands of years. In winter, as the surrounding oceans freeze, the area of Antarctica is almost double that in summer.

How dry is dry?

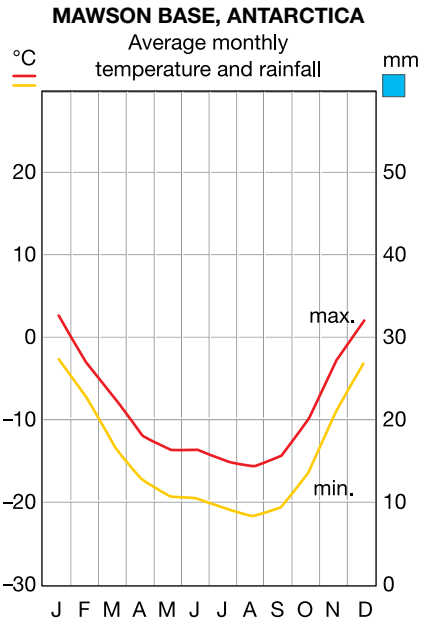
Covered in ice, Antarctica may seem like the wettest place in the world, but it's actually drier than the Sahara Desert. Despite this, Antarctica's ice holds 70 per cent of the world's fresh water supply.

Most places in Antarctica receive no rain or snow at all. Very cold air does not have the capacity to hold enough water to create rain or snow. This means that Antarctica is the world's biggest desert. All drinking water in Antarctica is obtained by melting the ice. Unlike in hot deserts, there is little evaporation from Antarctica, so the relatively small amount of snow that does fall doesn't disappear. Instead it builds up over hundreds and thousands of years into enormously thick ice sheets.

How cold is cold?

On 29 July 1983, Russian scientists at Vostok Base, high on Antarctica's polar plateau, recorded a temperature of –89.2 °C, the lowest on record. During the coldest months (July to August), the average temperature at the South Pole is –60 °C. During the warmest months (December to January), it rises to –28 °C.

FIGURE 2 A climograph for Mawson Base, Antarctica.



Why is Antarctica so cold?

There are three main reasons:

1. Antarctica's position on the globe means that the sun's rays strike the Earth's surface at a low angle, and therefore have a much larger area to heat than at other places on the planet.
2. Most of the sun's heat that does reach Antarctica is reflected back into space by the white ice that covers the continent. This also explains why you must always wear sunglasses or goggles in Antarctica.
3. Antarctica is surrounded by the cold waters of the Southern Ocean.

How windy is windy?

Australia's greatest polar explorer, Douglas Mawson, called Antarctica 'the home of the blizzard'. He should know. He lived in a wooden hut for two complete Antarctic winters, in the strongest winds ever recorded. Mawson's measurements revealed an average wind speed of over 70 kilometres per hour and gusts of over 300 kilometres per hour! The men in his expedition team always carried an ice axe with them to avoid being blown into the sea.

katabatic winds very strong winds that blow downhill

blizzards a strong and very cold wind containing particles of ice and snow that have been whipped up from the ground

sastrugi parallel wave-like ridges caused by winds on the surface of hard snow, especially in polar regions

Why is Antarctica so windy?

As the air over the polar plateau becomes colder, it becomes more dense. Finally gravity pulls it down off the plateau towards the Antarctic coast. This creates very strong winds, called **katabatic winds**, which can blow continually for weeks on end and carry small pellets of ice. These winds combined with the severe cold can be fatal; at –20 °C, exposed human flesh begins to freeze when the wind reaches only 14 kilometres per hour.

Katabatic winds also cause **blizzards**, which sweep up loose snow and blow it about ferociously. Such blizzards were the cause of death among many early Antarctic explorers.

The winds also shape the landscape, carving it into irregular shapes called **sastrugi** (see figure 3). These shapes range in height from 150 millimetres to two metres. Travelling across sastrugi is extremely difficult.extremely difficult.

FIGURE 3 Sastrugi lie in the direction of the prevailing wind. They are as hard as rock.



ACTIVITIES

IDENTIFY

1 List three facts about Antarctica that you found the most surprising.
2 Why does Antarctica double in area every winter?
3 What is the coldest temperature ever recorded in Antarctica, and in which ***place*** did this occur?

EXPLAIN

4 Antarctica is sometimes described as the world's biggest desert. Why?
5 Describe and explain why Antarctica is so dry, cold and windy.
6 Examine the photograph in figure 3 and describe how this landscape has been formed. How does this ***environment*** pose a risk to people?

INVESTIGATE

7 Use the **Antarctic weather** and **BOM** weblinks in the Resources tab to describe the weather conditions now at the South Pole. Compare these to the conditions where you live.
8 Use an atlas to measure the distance from Antarctica (coastline) to South America, Australia and South Africa.

PREDICT

9 What might happen to Antarctica if the ice shelves on top of the mountains were to melt? What ***changes*** might happen to sea levels around the world? Work with a partner to construct a concept map to record all your ideas.

APPLY

10 Use the information in table 1 to draw a climograph of McMurdo Station. How does it compare to Mawson Base (see figure 2)? Find climate data for the ***place*** where you live and draw another climograph for that location. Compare this to the two Antarctic climographs. Outline the similarities and differences and provide reasons for these.

TABLE 1 Climate data for the American McMurdo station in Antarctica: latitude 77.88°S, longitude 166.73°E

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average daily temperature (°C)	–2.9	–9.5	–18.2	–20.7	–21.7	–23.0	–25.7	–26.1	–24.6	–18.9	–9.7	–3.4	Mean –16.9
Mean monthly rainfall (mm)	15	21.2	24.1	18.4	23.7	24.9	15.6	11.3	11.8	9.7	9.5	15.7	Total 202.5

eBook*plus*

Weblinks
- Antarctic weather
- BOM

4.12 How do people use Antarctica?

4.12.1 Introduction

Antarctica and the seas that surround it contain valuable resources. Antarctica is also the temporary home of more than 4000 people in summer and 1000 in winter. Most are scientists and support staff. These people work in more than 66 research stations representing 30 different nations.

FIGURE 1 Esperanza, a permanent, all-year round Argentinian research base, Graham Land, Antarctica

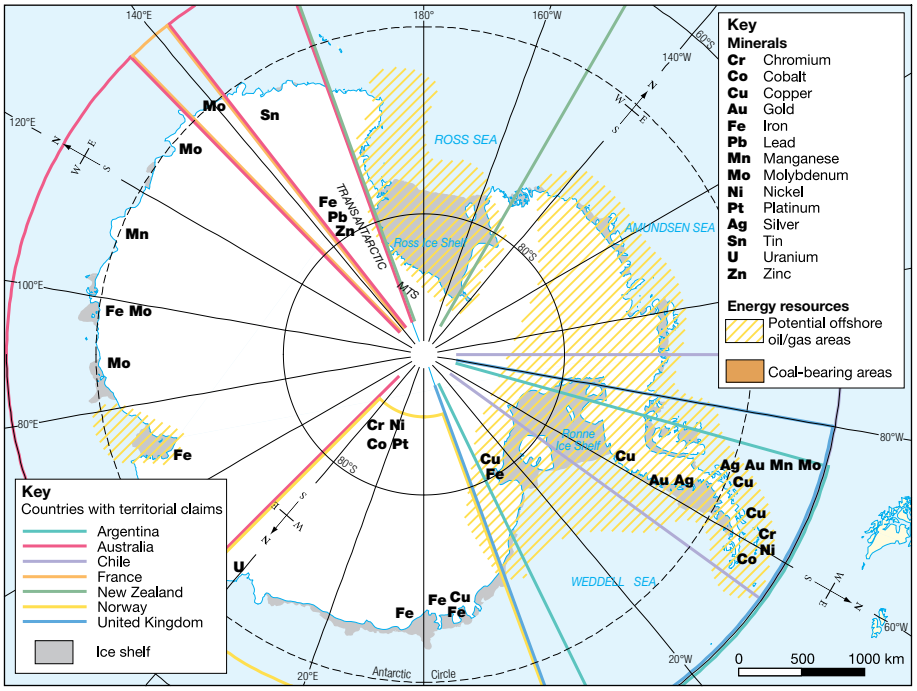


4.12.2 Mining

There are great difficulties in looking for mineral deposits in rocks that lie beneath thousands of metres of ice. Therefore, most exploration has taken place in the ice-free areas of Antarctica. Scientists now believe there are deposits of many valuable minerals in Antarctica, including coal, iron ore, copper, lead and uranium, and traces of minerals such as gold and zinc. There are also mineral beds lying under the continent's Transantarctic Mountains, and large areas that may contain deposits of oil and gas (see figure 2).

Despite the presence of these valuable minerals, there are no operating mines in Antarctica. Given the conditions — the extreme cold, the rough seas and the wind — mining operations would be very difficult and potentially dangerous to the environment. Mining (other than for scientific purposes) is banned under the Antarctic Treaty. This is to prevent the possibility of polluting the environment (for example, through an oil spill or by digging a quarry).

FIGURE 2 Potential sources of minerals in Antarctica



Source: © Geography Teachers' Association of Victoria, Inc.

The Antarctic Treaty

By the mid-1950s, Australia, New Zealand, the United Kingdom, France and Argentina were actively exploring Antarctica. These countries declared territorial claims over parts of Antarctica while others were fishing, whaling and conducting scientific research and mineral exploration in the region.

People began to realise that this unique wilderness needed to be protected. In 1958, 12 countries agreed to preserve Antarctica. This led to an international agreement called the Antarctic Treaty, which came into force in 1961. The **treaty** covers the area south of 60 °S latitude. It has been signed by more than 52 countries who meet regularly to discuss issues affecting Antarctica. The treaty:

treaty a formal agreement between two or more countries

- prohibits military activity
- protects the Antarctic environment
- fosters scientific research
- recognises the need to protect Antarctica from uncontrolled destruction and interference by people.

4.12.3 Tourism

The number of tourists to Antarctica has increased significantly since the mid-1990s, with a peak of more than 45 000 in 2007–08. However, more people will attend one game of AFL football in Melbourne than will visit Antarctica in one year. Given the scale (size) of Antarctica, tourist numbers are therefore still small.

Most tourists go to Antarctica on board cruise ships. There are opportunities for people to land on the ice. This often requires use of a Zodiac inflatable boat between ship and shore. There are no tourist facilities on Antarctica — people must return to the ships, for example, to sleep, eat and shower.

Sightseeing is the main activity for tourists. Other activities include kayaking, visiting research stations, walking and snowboarding. Other types of tourism include flights over the continent and flights that include landing on the ice.

Tourism can create problems, such as pollution from oil spills and disturbance to animal colonies. Therefore, the International Association of Antarctica Tour Operators has set up rules to control tourism. For example, no more than 100 passengers from a cruise ship may be landed at a location in Antarctica at any one time.

TABLE 1 Tourists to Antarctica

Year	Tourist numbers	Year	Tourist numbers
1996–97	7330	2006–07	29823
1997–98	9604	2007–08	46069
1998–99	10013	2008–09	37858
1999–2000	14762	2009–10	36975
2000–01	12248	2010–11	33824
2001–02	11588	2011–12	26509
2002–03	13571	2012–13	34354
2003–04	27537	2013–14	37405
2004–05	27950	2014–15	36702
2005–06	29823		

Source: International Association of Antarctica Tour Operators

Bases on ice

Most of Antarctica's scientific bases are located on the coast so people and supplies can be brought in by boat or air (see figure 3). They are also situated on the two per cent of Antarctica not covered in ice, as bases built on ice tend to sink under their own weight. This is because the heat they generate can melt ice around and beneath them.

Some bases are inland. There is even a permanent scientific base at the South Pole: the American Amundsen–Scott Base. Australia operates three permanent bases in Antarctica — Casey, Mawson and Davis stations — plus one on Macquarie Island and five temporary summer bases.

In January 2008 an air link between Australia and Antarctica was officially opened. The Wilkins runway is a four-kilometre-long airstrip about 70 kilometres from Casey Station. Scientists can now get to Antarctica in a few hours from Australia rather than a few weeks on a ship. They can study the world's weather, climate, marine and land biology, glaciers, magnetics, geology and the ozone layer, as well as human physiology. Ice cores can provide a record of climate change over a long period of time.

FIGURE 3 Davis is the most southerly Australian Antarctic station.



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **Antarctica: human features**

ACTIVITIES

IDENTIFY

1 List three ways in which the stations might have an impact on the Antarctic ***environment***.
2 Why is there no mining in Antarctica? What problems would there be in extracting and transporting minerals from Antarctica?

EXPLAIN

3 Suggest the ideal location for a scientific base in Antarctica.
4 Why don't tourists visit Antarctica during winter?

INVESTIGATE

5 Working in groups of four, use the **Life in Antarctica** weblink in the Resources tab to investigate life at the Australian Antarctic stations. Choose one station.
  a What facilities are there at the station?
  b Describe the work activities that take place.
  c What do you think it is like to live there?
6 Use a spreadsheet program to draw a line graph using the tourism data in table 1. Describe how the numbers have ***changed*** over time and provide one possible explanation for the drop in numbers since 2008.

PREDICT

7 Use the **Antarctic article** and **Biosecurity fears** weblinks in the Resources tab to find out more about how foreign seeds are invading Antarctica. Write a list of rules for a company that would remove this risk.

APPLY

8 Do you think countries should be able to own pieces of Antarctica? Write a two-minute speech outlining the reasons for your point of view. Debate this topic as a class.
9 Would you like to visit Antarctica? Why? Discuss as a class, listening carefully to the opinions of others.

eBook*plus*

Weblinks
- Life in Antarctica
- Antarctic article
- Biosecurity fears

4.13 Review

4.13.1 Review

Deserts and desert climate

1. Describe where the following desert types are located and give two examples of each.
   - Hot deserts
   - Cold deserts
2. Outline three ways in which deserts can form.
3. Why is Antarctica a desert? How is it different from other deserts?
4. a. Create a climograph of the following data for the Russian Vostok station in Antarctica.
   b. Compare this desert climate with the climate of hot deserts in Yuma in the United States, Khormaksar in Yemen and Alice Springs in Australia. Outline the similarities and differences. Why is each of these locations a desert? Which would be defined as hyper-arid, arid and semi-arid?

TABLE 1 Climate data for the Russian Vostok station in Antarctica (latitude: 78.45°S; longitude: 106.80°E)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average daily temperature (°C)	–32.1	–44.3	–57.9	–64.7	–65.6	–65.2	–66.9	–67.6	–66.0	–57.1	–43.3	–32.1	Mean –55.1
Mean monthly rainfall (mm)	0.1	0.0	0.7	0.5	0.4	0.5	0.6	0.7	0.3	0.2	0.1	0.0	Total 4.5

5. Name three landforms that can be found in desert ***environments***. For each, describe how wind, erosion, weathering and deposition help create the landform.
6. List three ways in which people use deserts.
7. List some of the resources that are mined in deserts.
8. How has technology allowed deserts to bloom?

4.13.2 Reflect

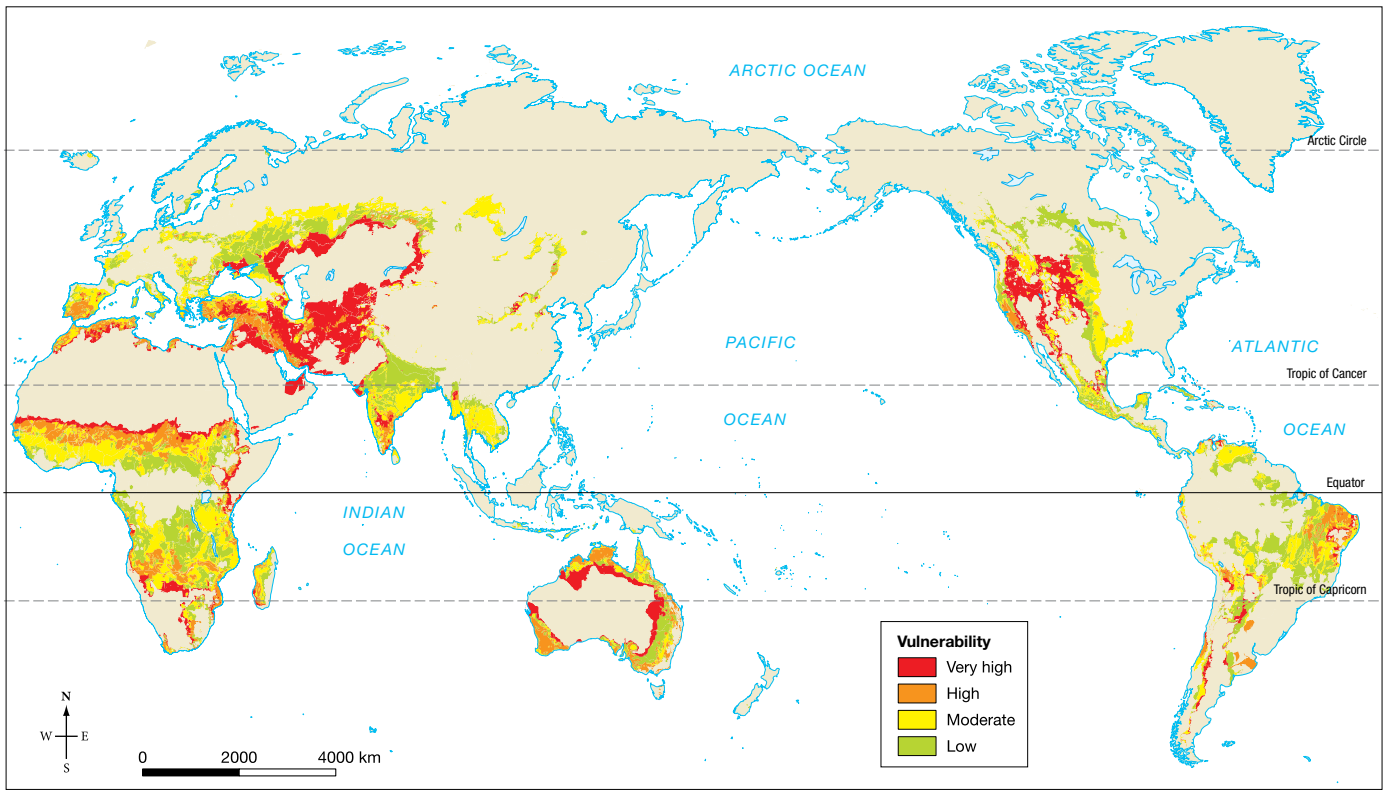
Expanding deserts

The world's deserts have been formed over long periods of time, and have grown and receded independently of people's use of the environment. But the transition zone between a desert and a more humid environment is very fragile and, if stressed, can become degraded.

Some human activities and natural causes in these transition zones can lead to desertification — the process by which useful agricultural land can change into desert. These activities include overgrazing by livestock, loss of trees and shrubs, poor farming methods, overpopulation and prolonged drought.

9. What is desertification?
10. Study the map in figure 1. Using an atlas to help you, describe the regions that are most vulnerable to desertification.
11. Compare this map with figure 1 in subtopic 4.2 showing the current distribution of deserts. What do these maps have in common?
12. List the activities that can cause desertification.

FIGURE 1 Map showing which parts of the world are most susceptible to becoming a desert



Source: Spatial Vision

Desertification in Nouakchott, Mauritania

Nouakchott is the capital city of Mauritania, located in West Africa. In 1960, Nouakchott was many days' walk from the edge of the Sahara Desert, but now this desert surrounds the city. In 1960, the city's population was 20 000; today it is more than one million, placing pressure on the land and its resources.

The Mauritanian government has planted 250 000 palm trees to try to stop the movement of sand. There are also plans to surround villages with green belts — tree plantations to stop sand entering the villages. Straw fences also help, as does the teaching of better farming practices to reduce erosion and sand movement.

13. Locate Mauritania and Nouakchott in an atlas. Describe their location in relation to the Sahara Desert — draw a small sketch map to help you.
14. Study the topographic map in figure 2.
    a. List some of the desert features that can be identified.
    b. There are no contour lines marked on this map — why do you think this is the case?
    c. How many wells can you count on the map? How many are saline? What does this mean?
    d. What evidence is there on the map that confirms desertification is a problem in this region?
    e. What human feature provides another source of water to this area?
15. Study the photograph shown in figure 3.
    a. Draw a sketch of this photograph and label the following:
        i. the dunes encroaching from the Sahara
        ii. the edge of the city of Nouakchott
        iii. fence lines surrounding plots.
    b. Add an arrow to show the direction of sand movement.
    c. Write a summary paragraph to describe how desertification is affecting Nouakchott.

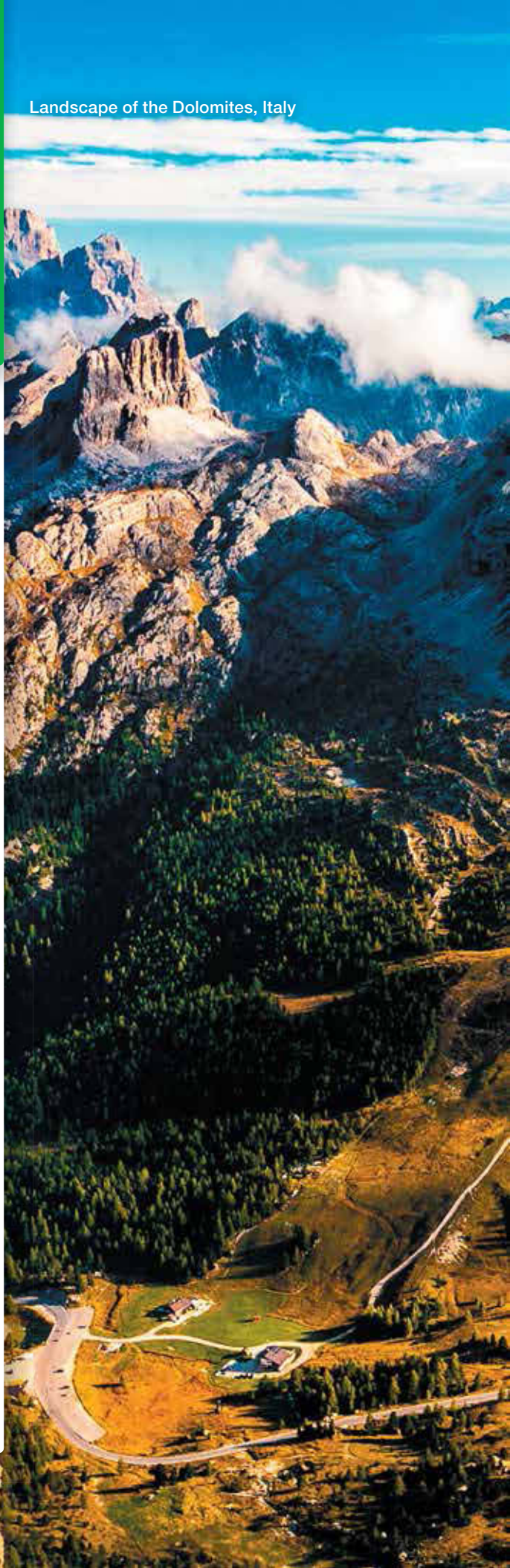
FIGURE 2 A topographic map of Nouakchott, Mauritania



Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 3 The Saharan sand dunes now reach up to Nouakchott. Sand is everywhere, piling up against walls and fences and covering roads.





Landscape of the Dolomites, Italy

CHAPTER 5

Mountain landscapes

5.1 Overview

5.1.1 Introduction

Mountains occupy 24 per cent of the Earth's landscape, and are characterised by many different landforms. The forces that form and shape mountains come from deep within the Earth, and have been shaping landscapes for millions of years. The Earth is a very active planet — every day, many volcanoes are erupting somewhere on the planet, and even more tremors are occurring.

Starter questions

1. What is the highest mountain you have visited? What did you do there?
2. Have you ever seen a volcano? Where was it?
3. Is there a mountain or mountain range you would like to visit? Why?
4. Have you ever felt an earthquake or earth tremor? Where were you when it happened? How did you react?
5. Watch the video to describe how movements in the Earth can transform and destroy the landscape.
6. How do mountains change where we live?

Inquiry sequence

		Syllabus outcomes
5.1 Overview		
5.2 Where are the world's mountains?		GE4-1, GE4-3, GE4-4
5.3 How do people use mountains?		GE4-1, GE4-3, GE4-4
5.4 What are the forces that form mountains?		GE4-2, GE4-5, GE4-7, GE4-8
5.5 How do different types of mountains form?		GE4-2, GE4-5, GE4-7, GE4-8
5.6 How do earthquakes and tsunamis occur?		GE4-2, GE4-5, GE4-7, GE4-8
5.7 What are the impacts of earthquakes and tsunamis?		GE4-4, GE4-5, GE4-7, GE4-8
5.8 SkillBuilder: Drawing a simple cross-section	eBookplus ONLINE ONLY	GE4-2, GE4-5, GE4-7, GE4-8
5.9 SkillBuilder: Interpreting an aerial photo	eBookplus ONLINE ONLY	GE4-2, GE4-5, GE4-7, GE4-8
5.10 How are volcanic mountains formed?	eBookplus ONLINE ONLY	GE4-2, GE4-5, GE4-7, GE4-8
5.11 Investigating topographic maps: How did Mount Taranaki form?		GE4-2, GE4-5, GE4-7, GE4-8
5.12 What is the anatomy of a volcano?		GE4-2, GE4-5, GE4-7, GE4-8
5.13 How do volcanoes affect people?		GE4-4, GE4-5, GE4-7, GE4-8
5.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Majestic mountains
Searchlight ID: eles-1626

5.2 Where are the world's mountains?

5.2.1 The world's mountains and ranges

A mountain is a landform that rises high above the surrounding land. Most mountains have certain characteristics in common, although not all mountains have all these features. Many have steep sides and form a peak at the top, called a summit. Some mountains located close together have steep valleys between them known as gorges.

Mountains make up a quarter of the world's landscape. They are found on every continent and in three-quarters of all the world's countries. Only 46 countries have no mountains or high plateaus, and most of these are small island nations.

Some of the highest mountains are found beneath the sea. Some islands are actually mountain peaks emerging out of the water. Even though the world's highest peak (from sea level) is Mount Everest in the Himalayas (8850 metres high), Mauna Loa in Hawaii is actually higher when measured from its base on the ocean floor (9170 metres high). Long chains or groups of mountains located close together are called a mountain range.

1 The Himalayas

Located in Asia, the Himalayas are the highest mountain range in the world. They extend from Bhutan and southern China in the east, through northern India, Nepal and Pakistan, and to Afghanistan in the west.

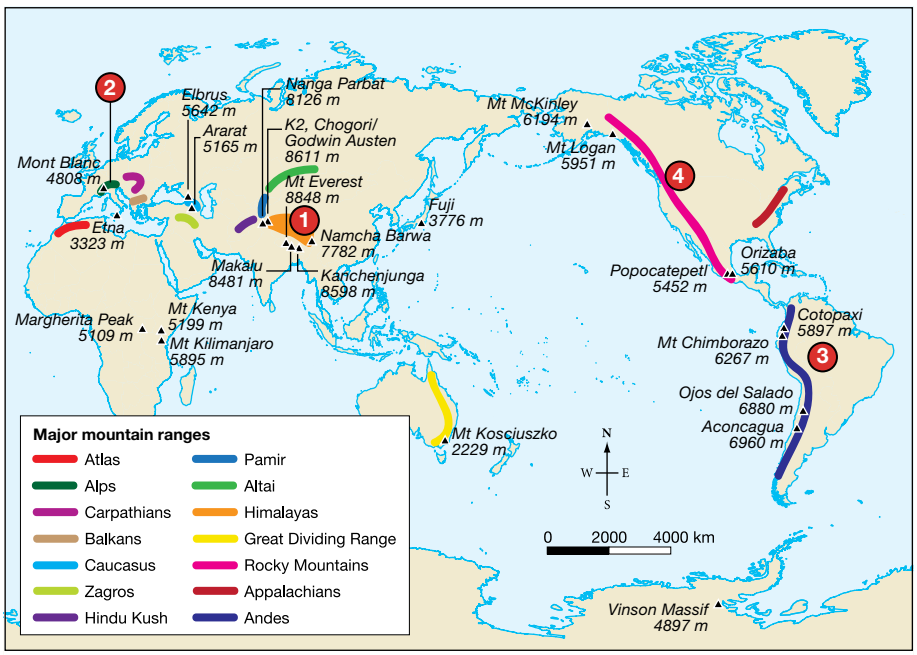
2 The Alps

The Alps, located in south central Europe, extend 1200 kilometres from Austria and Slovenia in the east, through Italy, Switzerland, Liechtenstein and Germany, to France in the west. The highest mountain in the Alps is Mont Blanc in France, which is 4808 metres high.

3 The Andes Mountains

The Andes Mountains are located in South America, extending north to south along the western coast of the continent. The Andes has many mountains over 6000 metres and, at 7200 kilometres long, it is the longest mountain range in the world.

FIGURE 1 The world's main mountains and mountain ranges



Source: Spatial Vision

4 The Rocky Mountains

The Rocky Mountains in western North America extend north–south from Canada to New Mexico, a distance of around 4800 kilometres. The other large mountain range in North America is the Appalachian Mountains, which extends 2400 kilometres from Alabama in the south to Canada in the north.

5.2.2 Mountain climate and weather

It is usually colder at the top of a mountain than at the bottom, because air gets colder with **altitude**. Air becomes thinner and is less able to hold heat. For every 1000 metres you climb, the temperature drops by 6 °C. The effect of this on vegetation is shown in figure 2.

altitude height above sea level

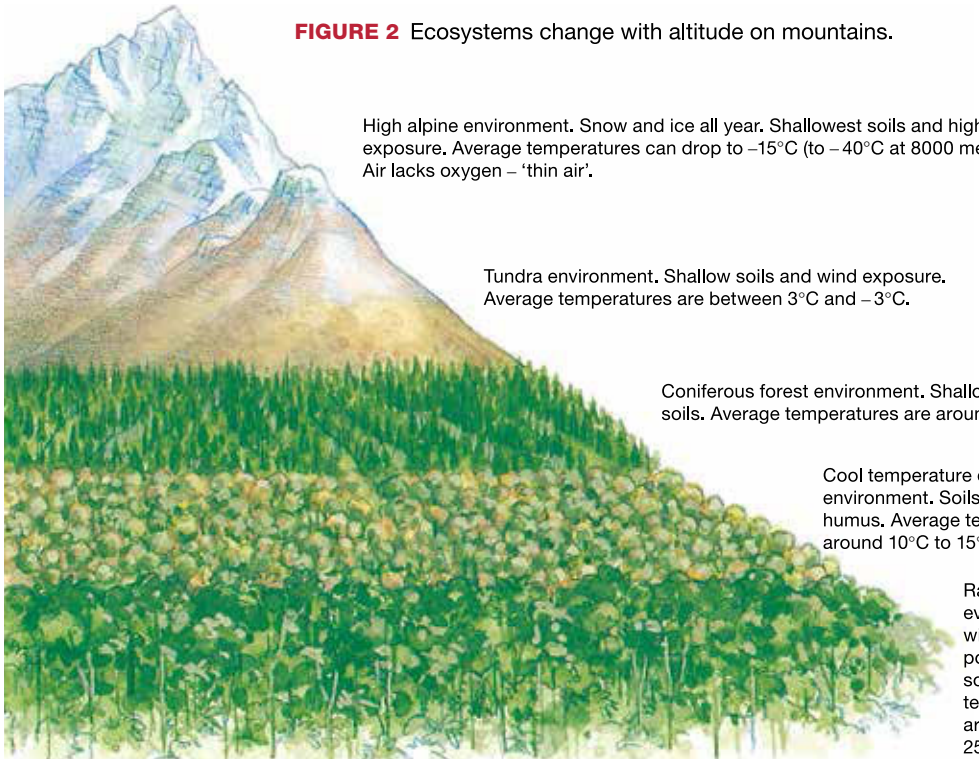


FIGURE 2 Ecosystems change with altitude on mountains.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
- **Himalayas**
- **Mountain environments**

FOCUS ON FIELDWORK

Vegetation identification

Using a vegetation identification chart to classify ecosystems

Vegetation identification charts provide us with information on plants to help identify them when undertaking fieldwork. They are a useful tool as they allow us not only to classify ecosystems but also to examine changes that occur within an environment. With the accessibility of technology, we no longer have to rely on paper identification charts. There are many different applications available on devices to help identify plants and animals. Draw a sketch to indicate the location of vegetation along a slope that has been selected on a field excursion.



ACTIVITIES

IDENTIFY

1 What percentage of the Earth's surface is covered by mountains?

EXPLAIN

2 Refer to figure 2. How does vegetation ***change*** on a mountain?

3 Refer to figure 1. Describe how the ***scale*** of the world's mountains varies across the continents.

APPLY

4 Locate and name the highest mountain closest to where you live in your state or territory.

5 Name a mountain located close to where you live. Name two other mountains in your state or territory. Where are they located in relation to your school or home?

6 Use the internet to find a photograph of a mountain environment. Sketch the photograph and identify the human and physical features of the environment.

INVESTIGATE

7 Work in groups of 4 to 6 to investigate some of the following mountain ranges.

- Antarctica — Antarctic Peninsula, Transantarctic Mountains
- Africa — Atlas Mountains, Eastern African Highlands, Ethiopian Highlands
- Asia — Hindu Kush, Himalayas, Taurus, Elburz, Japanese Mountains
- Australia — MacDonnell Ranges, Great Dividing Range
- Europe — Pyrenees, Alps, Carpathians, Apennines, Urals, Balkan Mountains
- North America — Appalachians, Sierra Nevada, Rocky Mountains, Laurentians
- South America — Andes, Brazilian Highlands

Each student should choose a different range, and complete the following.

a Map the location of the range in its region.

b Describe the climate experienced throughout the range.

c Name and provide images of a selection of plants and animals found in the range.

Present your information in Google maps.

5.3 How do people use mountains?

5.3.1 Mountain people and cultures

People have moved through and lived in mountain areas for centuries. But few people live in the world's highest mountain ranges, where it can be very cold and difficult to grow food and make a living. Thousands of people visit mountains, often in remote areas, for recreation and to see the spectacular scenery, plants and animals, historic and spiritual sites, and different cultures. Mountains are also vital for global water supply.

Around 12 per cent of the world's people live in mountain regions. About half of those live in the Andes, the Himalayas, and the various African mountains.

Usually, population density is very low in these areas. One reason for this is that mountains are very difficult to cross, as they are often rugged and covered with forests and wild animals. They can also be hard to climb and may have ice, snow or glaciers that make travel dangerous.

As a result of these difficulties, mountains have long provided a safe place for **indigenous peoples** and **ethnic minorities**. People live as nomads, hunters, foragers, traders, small farmers, herders, loggers and miners.

indigenous peoples the descendants of those who inhabited a country or region before people of different cultures or ethnic origins arrived

ethnic minority a group that has different national or cultural traditions from the main population

Mountain landscapes in the Dreaming

There are many examples of Aboriginal and Torres Strait Islander Dreaming stories that are linked to mountain landscapes. These legends help explain the formation and importance of each landscape and landform.

Australia's Indigenous people were guided by elders who knew the local Dreaming stories and customs. Dreaming stories were passed on through the generations and explained the origin of the world around them.

CASE STUDY 1

The Three Sisters legend in the Blue Mountains

There is a story, thought to be an Aboriginal legend, about the formation of the Three Sisters in the Blue Mountains in New South Wales (see figure 1). It tells of three sisters, Meehni, Wimlah and Gunnedoo, who lived in the Jamison Valley as members of the Gundungurra tribe. These young women had fallen in love with three brothers from the Dharruk tribe, yet tribal law forbade them to marry. The brothers were not happy with this law and so decided to use force to capture the three sisters, which caused a major tribal battle.

As the lives of the three sisters were seriously in danger, a clever man from the Katoomba tribe took it upon himself to turn the three sisters into stone to protect them from any harm. He intended to reverse the spell when the battle was over, but the clever man himself was killed. As only he could reverse the spell and bring the sisters back to life, they remain in their rock formation.

FIGURE 1 The Three Sisters in the Blue Mountains



CASE STUDY 2

Wollumbin on the New South Wales north coast

Wollumbin, also known as Mount Warning, is a site of cultural significance to the Bundjalung people. As the first place in Australia to see the sun each morning, Wollumbin represents a source of energy and life, making it a place of clan lore, initiation and spiritual learning. The ancient rainforests also provided food, medicines and shelter to several generations of the Bundjalung people. The walking track to reach the summit of Wollumbin is popular, but it is climbed against the wishes of the traditional owners.

The 1156-metre high peak is the central plug of a huge shield volcano that once dominated the landscape more than twenty million years ago. The caldera that is visible today was formed after a major explosion that caused the walls of the volcano to collapse. This site was recognised for its geological significance when it became protected as a World Heritage Area in 1986.

Captain James Cook gave Wollumbin the name Mount Warning in the eighteenth century as he wanted to warn others after his ship almost ran aground on nearby reefs.

FIGURE 2 Mt Warning



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Uluru

Sacred and special places

Mountain landscapes often have special meaning to certain groups of people. This might be because the location includes sacred sites or religious symbols; it might also be because people want to be close to nature or to feel spiritually inspired or renewed.

Mountaineers who take great risks, climbing alone or in small groups, often find a special meaning in mountain environments. These areas may hold deep spiritual, **cultural** and aesthetic (relating to beauty) values and ideas, and these will often inspire people to care for and protect mountain environments.

The following list gives examples of beliefs that are connected to mountains.

- Hindus and Buddhists have beliefs about Mount Kallas in the Himalayas.
- Hindus in Bali, Indonesia, have a special connection with Mount Gunung Agung.

cultural relating to the ideas, customs, and social behaviour of a society

FIGURE 3 Mount Everest





FIGURE 4 Mount Fuji

- Tibetan Buddhists revere Chomolungma (Mount Everest).
- The landscape of Demojong in the Himalayas is sacred to Buddhist Tibetans.
- Nanda Devi in the Himalayas is a sacred site for both Sikh and Hindu communities, and is a UNESCO World Heritage site.
- Mt Fuji is a place of spiritual and cultural symbolism to Japanese people.
- St Katherine Protectorate in South Sinai, Egypt, is in an area holy to Jews, Christians and Muslims.
- Jabal La'lam is a mountain that is sacred to the people of northern Morocco.

5.3.2 Skills to survive

It can be hard to make a living in mountain regions. People living in small, isolated mountain communities have learned to use the land and resources sustainably. Many practise shifting cultivation, migrate with grazing herds, and have terraced fields.

Some of the world's oldest rice terraces (see figure 5) are over 2000 years old. Rice and vegetables could be grown quite densely on the terraces. This enabled people to survive in a region with very steep slopes and high altitude.

FIGURE 5 The Longsheng rice terraces in China show how a mountainside can be changed to grow food.





FIGURE 6 Animals grazing in the Himalayas

On very high ranges, below the snowline is a treeless zone of alpine pastures that can be used in summer to graze animals (see figure 6). Elsewhere, in the valleys and foothills, agriculture often occurs, with fruit orchards and even vineyards on some sunny slopes. Not every human modification to mountain slopes, however, has been sustainable. Areas such as the Australian Alps were once used for cattle grazing, which resulted in erosion, soil structure damage and damage to alpine vegetation such as mosses.

Mountains supply 60 to 80 per cent of the world's fresh water. This is due to orographic rainfall (caused by warm, moist air rising and cooling when passing over high ground, such as a mountain; as the air cools, the water vapour condenses and falls as rain). Where precipitation falls as snow, water is stored in snowfields and glaciers. When these melt, they provide water to people when they need it most.

FOCUS ON FIELDWORK

Using clinometers to measure slopes

Clinometers measure the angle of a slope, indicating how steep the incline or decline is. Measuring slopes is a useful fieldwork tool to help work out the gradient of the various slopes around us. Clinometers can come in many forms and are easily made or used through an app on a phone or other device. Additionally, clinometers can give us the height of tall objects by using simple trigonometry calculations.

Measure and record the slopes around your school area or peaks in your local landscape.

Consider these questions:

- Was there any evidence of erosion on the slopes around your area?
- Was there more or less erosion on different slopes?
- What was the vegetation like on these slopes?

FIGURE 7 A handmade clinometer



FIGURE 8 A student using a clinometer



ACTIVITIES

IDENTIFY

1 List the geographical characteristics of mountains that limit the number of people who live there.
2 What type of work and recreation can people undertake in mountain regions? Present this information in words or in a diagram.

EXPLAIN

3 Think of a mountain you have visited or seen. Do you feel inspired by mountain environments? How can spiritual or religious beliefs linked to mountain landscapes help in protecting them?
4 How has the natural mountain ***environment*** in figure 1 been ***changed*** by people? Sketch the photo and make notes to show the ***changes***. You may wish to review the *Constructing a field sketch* SkillBuilder in your eBookPLUS.
5 Imagine you work as a park ranger in the Blue Mountains or Wollumbin. How can the Dreamtime legends of the region help other people understand this ***environment***?
6 Describe how different groups of people value mountainous ***places***.

APPLY

7 Use the internet to find photographs of Nepal in the Himalayas. Use these photographs to examine the ways that the Nepalese people use the mountain environment. Complete further research on the traditional Sherpa lifestyle and describe their connection with the land.

PREDICT

8 Draw and annotate a picture to show how and why mountains are important for water supply. Now add information to your picture in the form of annotations or additional drawings about what might happen if this was reduced for some reason; for example, through climate ***change***.

INVESTIGATE

9 Use the internet to locate the Jamison Valley in the Blue Mountains. Describe its location.
10 From this section, choose one of the Hindu or Buddhist beliefs linked to mountains. Use the internet to find out details of this connection. Present your information as a print or electronic brochure.
11 Research where your water supply comes from. How do mountains determine your water supply and availability?

5.4 What are the forces that form mountains?

5.4.1 Continental plates

Mountains and mountain ranges have formed over billions of years from tectonic activity; that is, movement in the Earth's crust. The Earth's surface is always changing — sometimes very slowly and sometimes dramatically.

The Earth's crust is cracked, and is made up of many individual moving pieces called continental plates, which fit together like a jigsaw puzzle (see figure 1). These plates float on the semi-molten rocks, or magma, of the Earth's mantle. Enormous heat from the Earth's core, combined with the cooler surface temperature, creates **convection currents** in the magma. These currents can move the plates by up to 15 centimetres per year. Plates beneath the oceans move more quickly than plates beneath the continents.

convection current a current created when a fluid is heated, making it less dense, and causing it to rise through surrounding fluid and to sink if it is cooled. A steady source of heat can start a continuous current flow.

Continental drift

Scientific evidence shows that, about 225 million years ago, all the continents were joined.

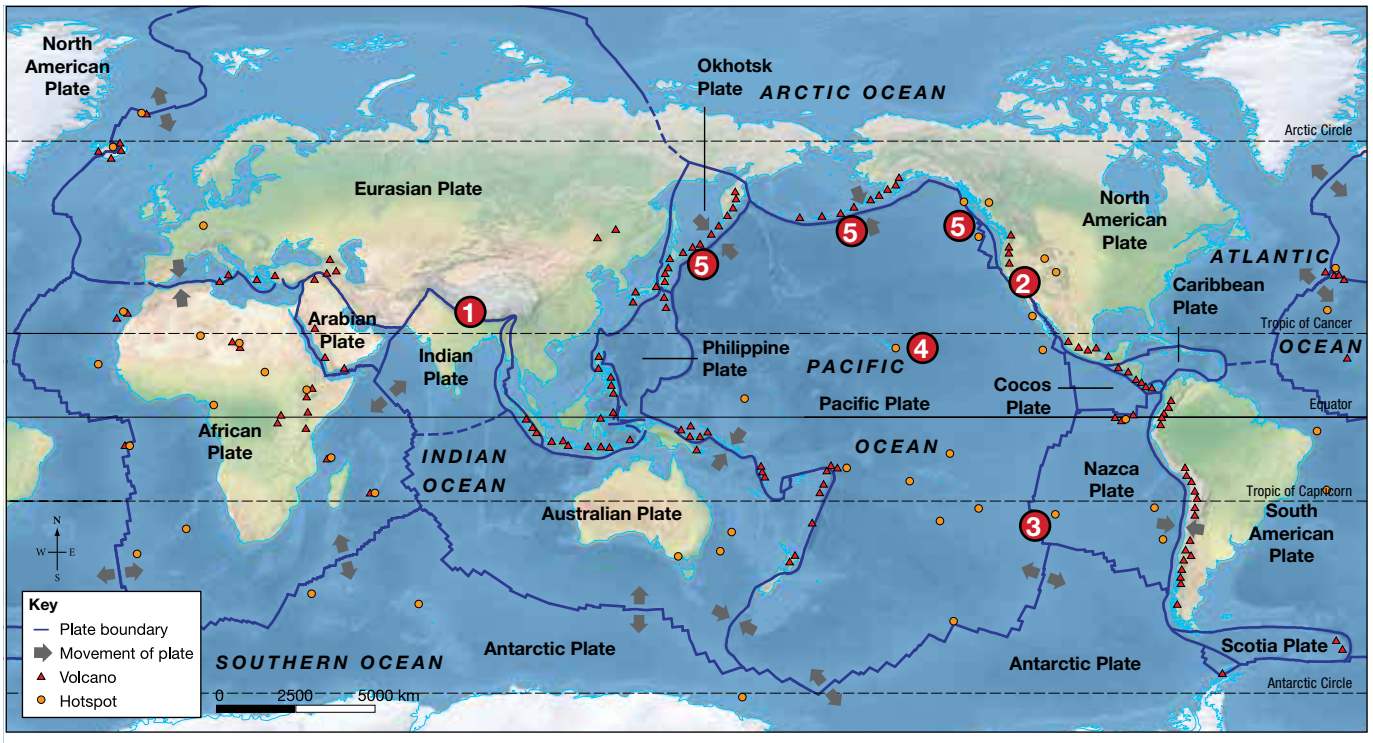
1 Convergent plates

When two continental plates of similar density collide, the pressure of the **converging plates** can push up land to form mountains. The Himalayas were formed by the collision of the Indian subcontinent and Asia (see figure 1). The European Alps were formed by the collision of Africa and Europe.

When an oceanic and a continental plate collide, they are different densities, and the thinner oceanic plate is subducted, meaning it is forced down into the mantle. Heat melts the plate and pressure forces the molten material back to the surface. This can produce volcanoes and mountain ranges (see figure 2). The Andes in South America were formed this way.

converging plate a tectonic boundary where two plates are moving towards each other

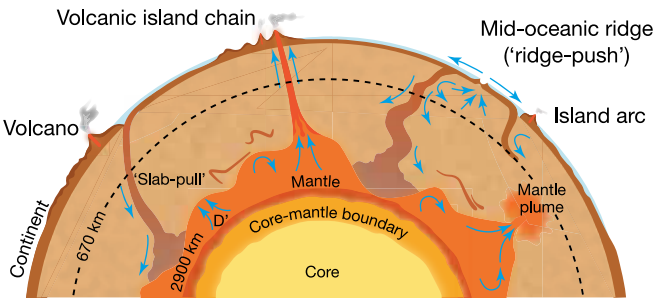
FIGURE 1 World map of plates, volcanoes and hotspots



Source: Spatial Vision

Subduction can also occur when two oceanic plates collide. This forms a line of volcanic islands in the ocean about 70–100 kilometres past the subduction line. The islands of Japan have been formed in this way. Deep oceanic trenches are also formed when this occurs. The Mariana Trench in the Pacific Ocean is 2519 kilometres long and 71 kilometres wide, and is the deepest point on Earth — 10.911 kilometres deep. If you could put Mount Everest on the ocean floor in the Marianas Trench, its summit would lie about 1.6 kilometres below the ocean surface.

FIGURE 2 The Earth's core is very hot, while its surface is quite cool. This causes hot material within the Earth to rise until it reaches the surface, where it moves sideways, cools, and then sinks.



2 Lateral plate slippage

Convection currents can sometimes cause plates to slide, or slip, past one another, forming **fault** lines. The San Andreas Fault, in California in the western United States, is an example of this (see figure 1).

fault an area on the Earth's surface that has a fracture, along which the rocks have been displaced

3 Divergent plates

In some areas, plates are moving apart, or diverging, from each other (for example, the Pacific Plate and Nazca Plate; see figure 1). As the **divergent plates** separate, magma can rise up into the opening, forming new land. Underwater volcanoes and islands are formed in this way.

divergent plate a tectonic boundary where two plates are moving away from each other and new continental crust is forming from magma that rises to the Earth's surface between the two

4 Hotspots

There are places where volcanic eruptions occur away from plate boundaries. This occurs when there is a weakness in the oceanic plate, allowing magma to be forced to the surface, forming a volcano. As the plate drifts over the hotspot, a line of volcanoes is formed (for example, Hawaii; see figure 1).

5 The Pacific Ring of Fire

The most active region in the world is the Pacific Ring of Fire. It is located on the edges of the Pacific Ocean and is shaped like a horseshoe (see figure 1). The Ring of Fire is a result of the movement of tectonic plates. For example, the Nazca and Cocos plates are being subducted beneath the South American Plate, while the Pacific and Juan de Fuca plates are being subducted beneath the North American Plate. The Pacific Plate is being subducted under the North American Plate on its east and north sides, and under the Philippine and Australian plates on its west side. The Ring of Fire is an almost continuous line of volcanoes and earthquakes. Most of the world's earthquakes occur here, and 75 per cent of the world's volcanoes are located along the edge of the Pacific Plate.

ACTIVITIES

IDENTIFY

1 Look at figure 2. How do convection currents help explain plate tectonics?
2 Refer to figure 1. Name three ***places*** where plates are converging. What mountain ranges, if any, are located in these ***places***?

EXPLAIN

3 Explain, in your own words, the meaning of subduction when referring to plate movements.
4 Name two locations where plates are moving apart. What is happening to the sea floor in these ***places***?
5 Describe the distribution of volcanoes shown in figure 1. What does this distribution have in common with the location of plate boundaries?

APPLY

6 Use different coloured strips of plasticine to make models showing how a collision of continental and oceanic plates differs from a collision of two continental plates. Have a go at explaining this to a member of your family.

PREDICT

7 Watch the **Drifting continents** video in your eBookPLUS (eles-0129) explaining how continents move. Based on the direction of movement, draw a sketch to show what you think the world's continents will look like many years into the future. Justify your predictions.

INVESTIGATE

8 Use the **Dynamic Earth** weblink in your eBookPLUS to explore the Earth's structure and the movement of the continental plates. Work through the activities and complete the challenges to investigate the movements beneath the Earth's crust. Use your findings to create a comic strip to explain how various landforms are created.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Active Earth

eBookplus

eLesson
Drifting continents
Watch this video to learn more about how the continents were once all joined and how they have moved apart.
Searchlight ID: eles-0129

Interactivity
Mountain builders
Use this interactivity to examine the forces that create mountains.
Searchlight ID: int-3109

Weblink
Dynamic Earth

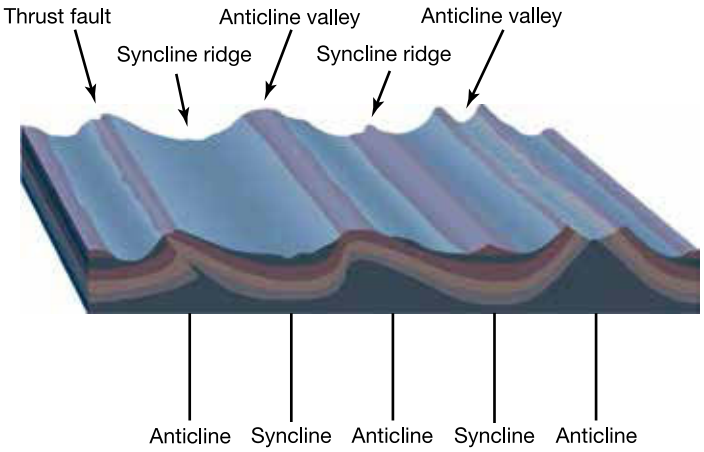
5.5 How do different types of mountains form?

5.5.1 Types of mountains

lithosphere the Earth's crust, including landforms, rocks and soil

The different movements and interactions of the **lithosphere** plates result in many different mountain landforms. Mountains can be classified into five different types, based on what they look like and how they were formed. These are fold, fault-block, dome, plateau and volcanic mountains. (Volcanic mountains are discussed in section 4.7.)

FIGURE 1 The formation of fold mountains



Fold mountains

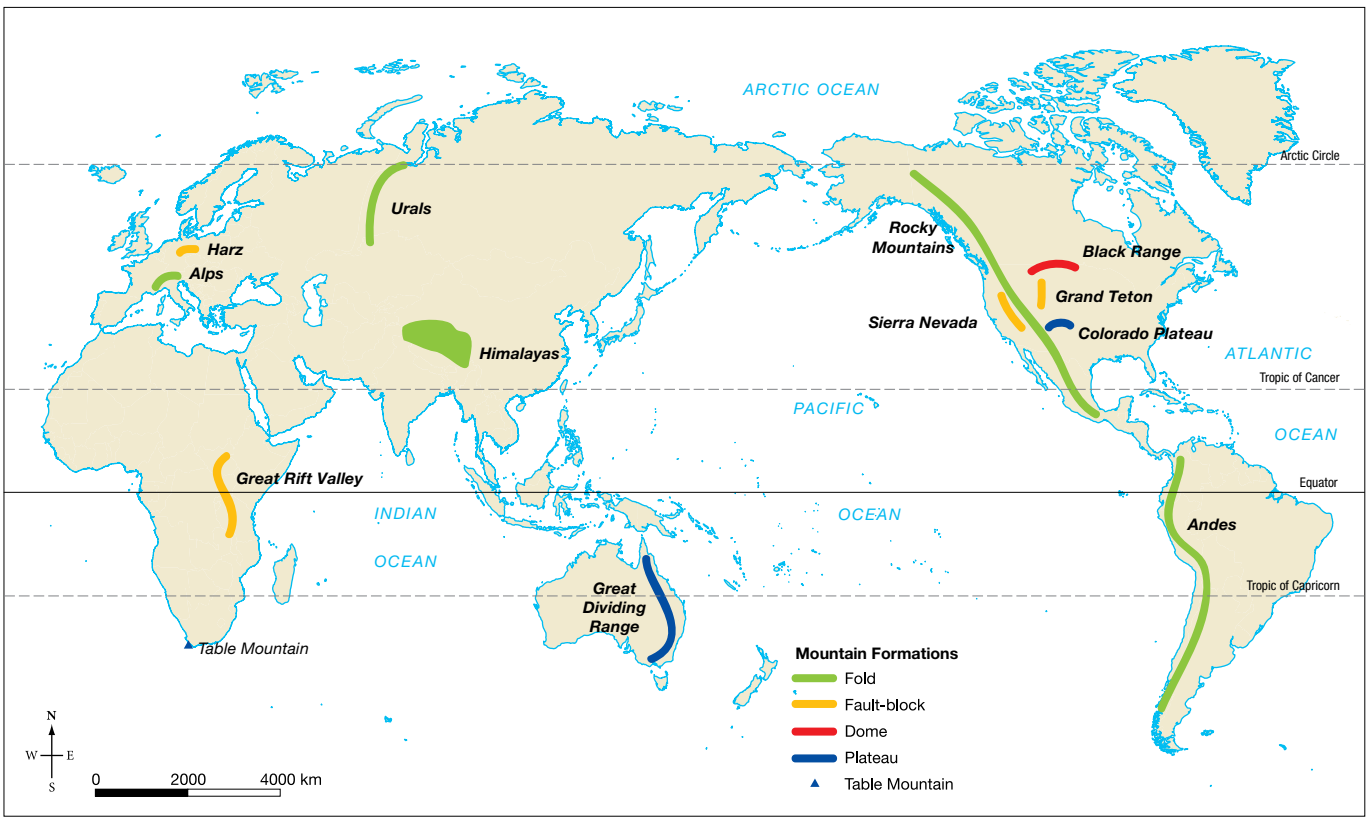
The most common type of mountain, and the world's largest mountain ranges, are fold mountains. The process of folding occurs when two continental plates collide, and rocks in the Earth's crust buckle, fold and lift up. The upturned folds are called anticlines, and the downturned folds are synclines (see figure 1). These mountains usually have pointed peaks.

Use the **Anticline and syncline** weblink in your eBookPLUS to see the formation of fold mountains.

Examples of fold mountains include:

- the Himalayas in Asia
- the Alps in Europe
- the Andes in South America
- the Rocky Mountains in North America
- the Urals in Russia (see figure 2).

FIGURE 2 Selected world mountains



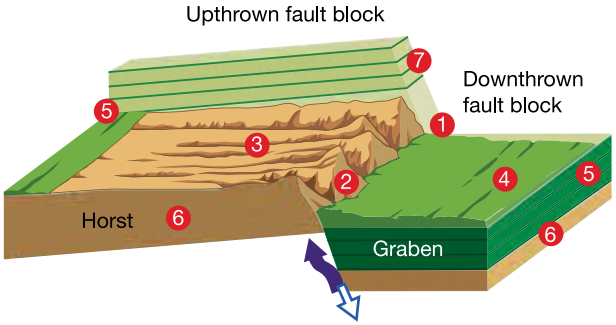
Source: Spatial Vision

Fault-block mountains

Fault-block mountains form when pressure within the Earth forces some parts of rock up and other parts to collapse down, along a fault line (or crack) in the Earth's crust. Instead of folding, the crust fractures (pulls apart) and breaks into blocks. The exposed parts then begin to erode and shape mountains and valleys (see figure 3).

Fault-block mountains usually have a steep front side and then a sloping back. The Sierra Nevada and Grand Tetons in North America, the Great Rift Valley in Africa (see figure 4), and the Harz Mountains in Germany are examples of fault-block mountains. Another name for the uplifted blocks is *horst*, and the collapsed blocks are *graben*.

FIGURE 3 The formation of fault-block mountains



1. Fault zone
2. Steep eastern face
3. Gentle western slope
4. Valley floors filled with sediments of cobbles, gravel and sand
5. Sedimentary rock layers
6. Bedrock
7. Sedimentary rock layers (5) now worn away.

eBook*plus*

Weblink
Anticline and syncline

Dome mountains

Dome mountains are named after their shape, and are formed when molten magma in the Earth's crust pushes its way towards the surface. The magma cools before it can erupt, and it then becomes very hard. The rock layers over the hardened magma are warped upwards to form the dome. Over time, these erode, leaving behind the hard granite rock underneath (see figure 5). Ben Nevis in Scotland is an example of a dome mountain (see figure 6).

Plateau mountains

Plateaus are high areas of land that are large and flat. They have been pushed above sea level by tectonic forces or have been formed by layers of lava. Over billions of years, streams and rivers cause erosion, leaving mountains standing between valleys. Plateau mountains are sometimes known as erosion mountains.

FIGURE 4 A cliff overlooking the Great Rift Valley in northern Tanzania. These are examples of fault-block mountains.



FIGURE 5 Very hot magma pushes towards the surface to form dome mountains.

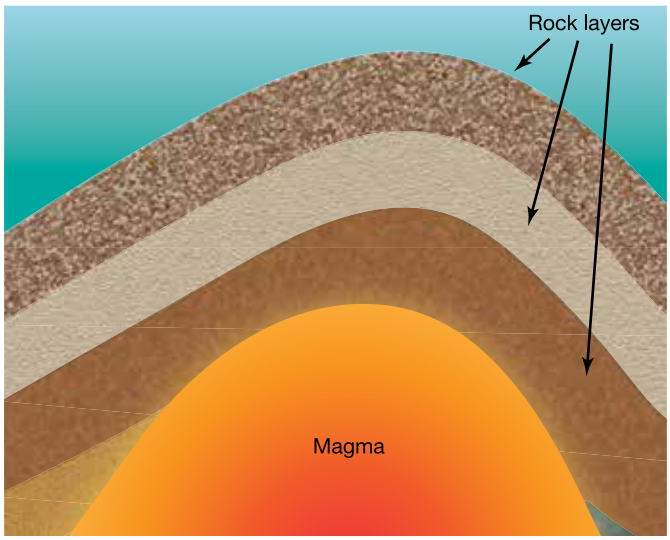


FIGURE 6 Ben Nevis in Scotland is a famous example of a dome mountain.



CASE STUDY 1

How were the Himalayas formed?

Before the theory of tectonic plate movement, scientists were puzzled by findings of fossilised remains of ancient sea creatures near the Himalayan peaks. Surely these huge mountains could not once have been under water?

Since understanding plate movements, the mystery has been solved. About 220 million years ago, India was part of the ancient supercontinent we call **Pangaea**. When Pangaea broke apart, India began to move northwards at a rate of about 15 centimetres per year. About 200 million years ago, India was an island separated from the Asian continent by a huge ocean.

When the plate carrying India collided with Asia 40 to 50 million years ago, the oceanic crust (carrying fossilised sea creatures) slowly crumpled and was uplifted, forming the high mountains we know today. It also caused the uplift of the Tibetan Plateau to its current position. The Bay of Bengal was also formed at this time.

The Himalayas were thus formed when India crashed into Asia and pushed up the tallest mountain range on the continents (see figure 7).

The Himalayas are known as young mountains, because they are still forming. The Indo-Australian plate is still moving northwards at about 2 centimetres each year, making this boundary very active. It is predicted that over the next 10 million years it will travel more than 180 kilometres into Tibet and that the Himalayan mountains will increase in height by about five millimetres each year. Old mountains are those that have stopped growing and are being worn down by the process of erosion.

Pangaea the name given to all the landmass of the Earth before it split into Laurasia and Gondwana

FIGURE 7 The movement of the Indian landmass to its current location



Source: MAPgraphics Pty Ltd Brisbane

CASE STUDY 2

Formation of the Sierra Nevada Range, United States

The Sierra Nevada Range began to rise about five million years ago. As the western part of the block tilted up, the eastern part dropped down. As a result there is a long, gentle slope towards the west and a steep slope to the east, as shown in figures 8 and 9.

FIGURE 8 The Sierra Nevada range was formed by fault-block tilting.

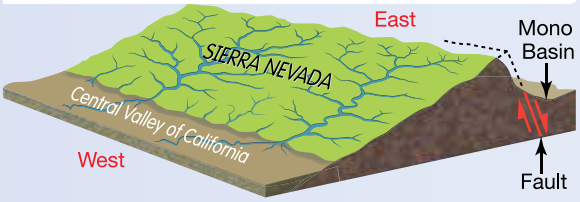


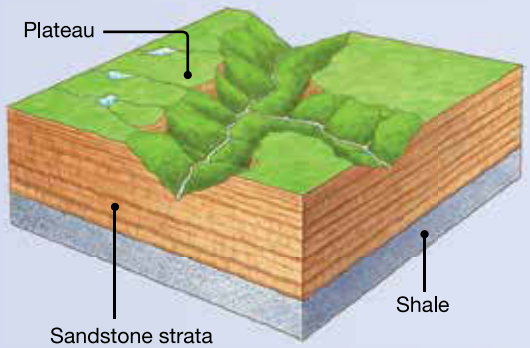
FIGURE 9 Yosemite Valley in the Sierra Nevada mountains



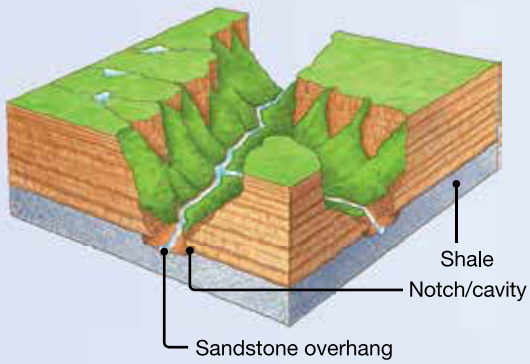
CASE STUDY 3

The Blue Mountains: Cliffs and gorges

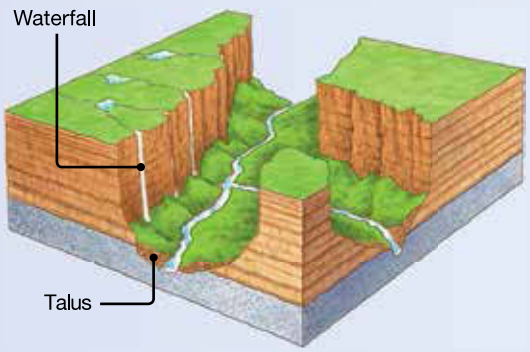
The Blue Mountains is a mountainous region located west of Sydney. It consists of a flat-topped mountain (a plateau) and sheer cliffs. Deep and narrow gorges, up to 760 metres deep, formed as rivers and creeks eroded the sandstone plateau over thousands of years.



Between 280 and 250 million years ago, about 500-metre layers of shales, siltstones and mudstones were laid by streams when they reached a shallow sea. Then, about 250 and 170 million years ago, large rivers deposited a 300-metre thick layer of sand on top of the shales. These layers were formed into sandstone by heat and pressure.



As creeks and rivers flowed across the plateau, they eroded through the plateau. The broken down sand and silt in the river water helped scour deeper into the plateau. When the rivers reached the shale layer they cut down even more easily as shale is relatively soft. Notches, or cavities, formed and undermined the more resistant sandstone.



The sandstone overhangs broke off and collapsed, leaving rubble. Shale provides soils on which vegetation can grow. Waterfalls form where they flow over harder sandstone.

eBook*plus*

Interactivity
Grand peaks
Use this interactivity to learn about different types of mountains.
Searchlight ID: int-3110

ACTIVITIES

IDENTIFY

1 List one example of fold, fault, dome and plateau mountains. Where is each located?
2 State whether the following statements are true or false.
  a Fold mountains are the most common type of mountain in the world.
  b The Sierra Nevada Range was formed by the eastern part of a fault-block tilting up.

EXPLAIN

3 Use the **Fold mountains** weblink in your eBookPLUS to explain the formation of fold mountains.
4 Use the video to explain the formation of fault-block mountains.
5 How does the shape of each of the mountains shown in this section provide clues as to how they were formed? How have the effects of erosion ***changed*** these mountains?
6 Use figures 5 and 6 to explain the formation of dome mountains.
7 Sketch figure 6 and annotate it to show where erosion has taken place. Label ***places*** that have hard and weak rocks.
8 Draw a sketch of figure 11, noting the plateau and areas of erosion and weathering.

INVESTIGATE AND PREDICT

9 Refer to subtopic 5.4, which describes the formation of the Himalayas.
  a Provide an explanation why scientists found ancient sea fossils on top of the Himalayas.
  b Describe how the Himalayas were formed. How long did it take for the plate carrying India to crash into Asia? Explain why these mountains are described as 'young' mountains.
  c Based on the movements occurring, predict what might happen to the Himalayas in the future.

eBookplus

Weblink
Fold mountains

5.6 How do earthquakes and tsunamis occur?

5.6.1 Earthquakes

Earthquakes and tsunamis are frightening events and often strike with little or no warning. An earthquake can shake the ground so violently that buildings and other structures collapse, crushing people to death. If an earthquake occurs at sea, it may cause a tsunami, which produces waves of water that move to the coast and further inland, sometimes with devastating effects.

focus the point where the sudden movement of an earthquake begins

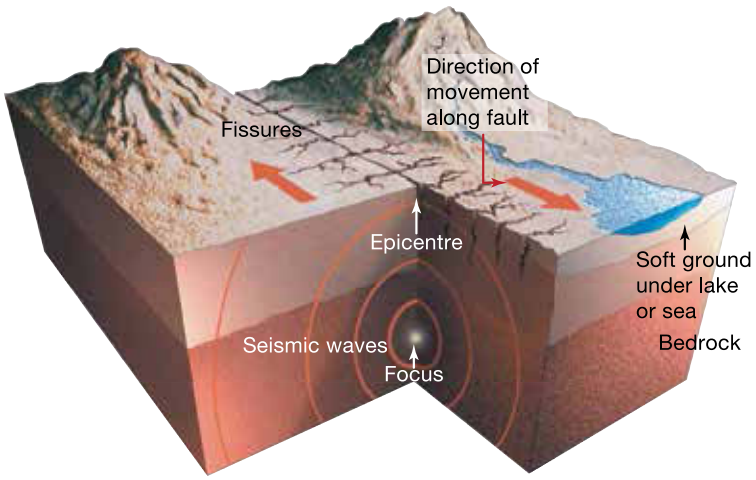
seismic waves waves of energy that travel through the Earth as a result of an earthquake, explosion, or a volcanic eruption

epicentre the point on the Earth's surface vertically above the focus

Earthquakes occur every day somewhere on the planet, usually on or near the boundaries of tectonic plates. The map in section 4.3, figure 1, shows a strong relationship between the location of plate boundaries and the occurrence of earthquakes. Weaknesses and cracks in the Earth's crust near these plate boundaries are called faults. An earthquake is usually a sudden movement of the layers of rock at these faults.

The point where this earthquake movement begins is called the **focus** (see figure 1). Earthquakes can occur near the surface or up to 700 kilometres below. The shallower the focus, the more powerful the earthquake will be. Energy travels quickly from the focus point in powerful **seismic waves**, radiating out like ripples in a pond. The seismic waves decrease in strength as they travel away from the **epicentre**. The energy released from an earthquake is measured on the Richter scale.

FIGURE 1 What happens in an earthquake?



The energy released at the focus can be immense, and it travels in seismic waves through the mantle and crust of the Earth. Primary waves, or P-waves, are the first waves to arrive, and are felt as a sudden jolt. Depending on the type of rock or water in which they are moving, these waves travel at speeds of up to 30 000 kilometres an hour.

Secondary waves, or S-waves, arrive a few seconds later and travel at about half the speed of P-waves. These waves cause more sustained up-and-down movement.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› Haiti earthquake
› Banda Aceh tsunami

Surface waves radiate out from the epicentre and arrive after the main P-waves and S-waves. These move the ground either from side-to-side, like a snake moving, or in a circular movement.

Even very strong buildings can collapse with these stresses. The energy that travels in waves across the Earth's surface can destroy buildings many kilometres away from the epicentre.

Measuring earthquakes

Earthquakes are measured according to their magnitude (size) and intensity. Magnitude is measured on the Richter scale, which shows the amount of energy released by an earthquake. The scale is open-ended as there is no upper limit to the amount of energy an earthquake might release. An increase of one in the scale is 10 times greater than the previous level. For example, energy released at the magnitude of 7.0 is 10 times greater than the energy released at 6.0.

Earthquake intensity is measured on the Modified Mercalli scale, and indicates the amount of damage caused. Intensity depends on the nature of buildings, time of day and other factors.

CASE STUDY 1

The Nepal earthquake, 2015

A magnitude 7.3 earthquake struck Nepal on 25 April 2015. Hundreds of thousands of people were made homeless with entire villages flattened (see figure 2). The earthquake killed more than 8000 people and injured more than 23 000 people while also triggering an avalanche on Mount Everest which killed an additional 18 people. The earthquake epicentre was east of the district of Lamjung and the focus was approximately 15 kilometres deep. The earthquake triggered several aftershocks and caused Mount Everest to move 3 centimetres to the south-west.

Nepal is located on the boundary of two huge moving plates — the Indo-Australian and Asian plates — that collide, making it very prone to earthquakes (see figure 3). It is the collision of these plates that has created the Himalaya mountain range.

FIGURE 2 Damage caused by the Nepal earthquake in 2015



FIGURE 3 Location of Nepal



Source: Spatial Vision

5.6.2 Tsunamis

A tsunami is a large ocean wave that is caused by sudden motion on the ocean floor. The sudden motion could be caused by an earthquake, a volcanic eruption or an underwater landslide. About 90 per cent of tsunamis occur in the Pacific Ocean, and most are caused by earthquakes that are over 6.0 on the Richter scale.

A tsunami at sea will be almost undetectable to ships or boats. The reasons for this are that the waves travel extremely fast in the deep ocean (about 970 kilometres per hour — as fast as a large jet) and the wavelength is about 30 kilometres, yet the wave height is only one metre.

When tsunamis reach the continental slope, several things happen. Firstly, the wave slows down and, as it does, the wave height increases and the wavelength decreases; in other words, the waves get higher and closer together. Sometimes, the sea may recede quickly, very far from shore, as though the tide has suddenly gone out. If this happens, the best course of action is to head to higher ground as quickly as possible.

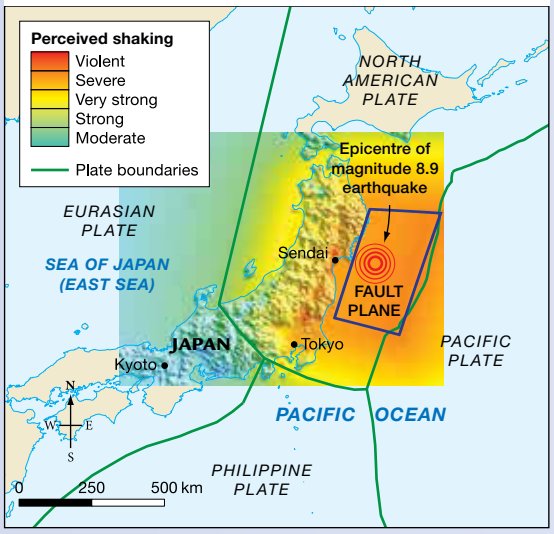
CASE STUDY 2

The Japanese tsunami, 2011

The region of Japan is seismically active because four plates meet there: the Eurasian, Philippine, Pacific and Okhotsk. Many landforms in this region are influenced by the collision of oceanic plates. Chains of volcanic islands called island arcs are formed, and an ocean trench is located parallel to the island arc (see figure 1 in section 5.4).

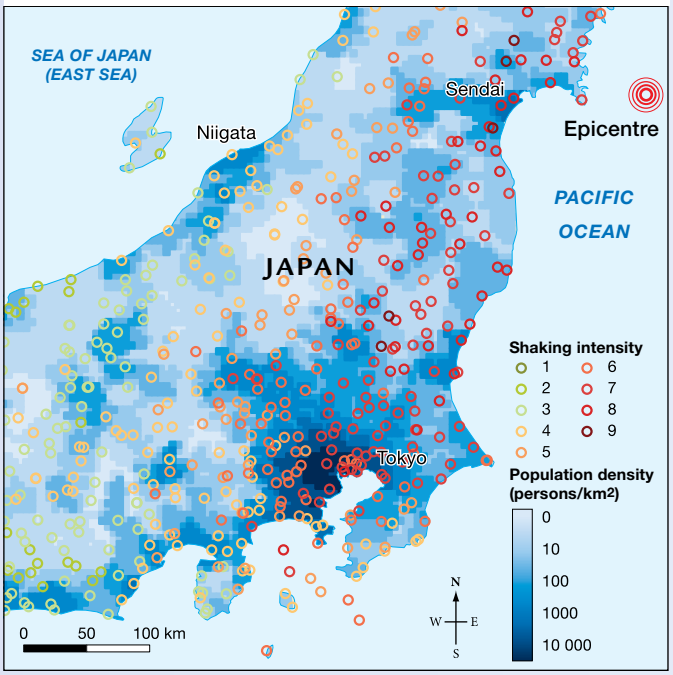
On 11 March 2011, an 8.9-magnitude earthquake struck near the coast of Japan. The earthquake was caused by movement between the Pacific Plate and the North American Plate (see figure 4). It occurred about 27 kilometres below the Earth's surface along the Japan Trench, where the Pacific Plate moves westwards at about eight centimetres each year. The sudden upward movement released an enormous amount of energy and caused huge displacement of the sea water, causing the tsunami. When the tsunami reached the Japanese coast, waves more than six metres high moved huge amounts of water inland. Strong aftershocks were felt for a number of days. Nearly 16 500 people were killed and 4800 were reported missing.

FIGURE 4 The location and magnitude of the earthquake that caused the Japanese tsunami



Source: Spatial Vision

FIGURE 5 This map shows the ground motion and shaking intensity from the earthquake across Japan.



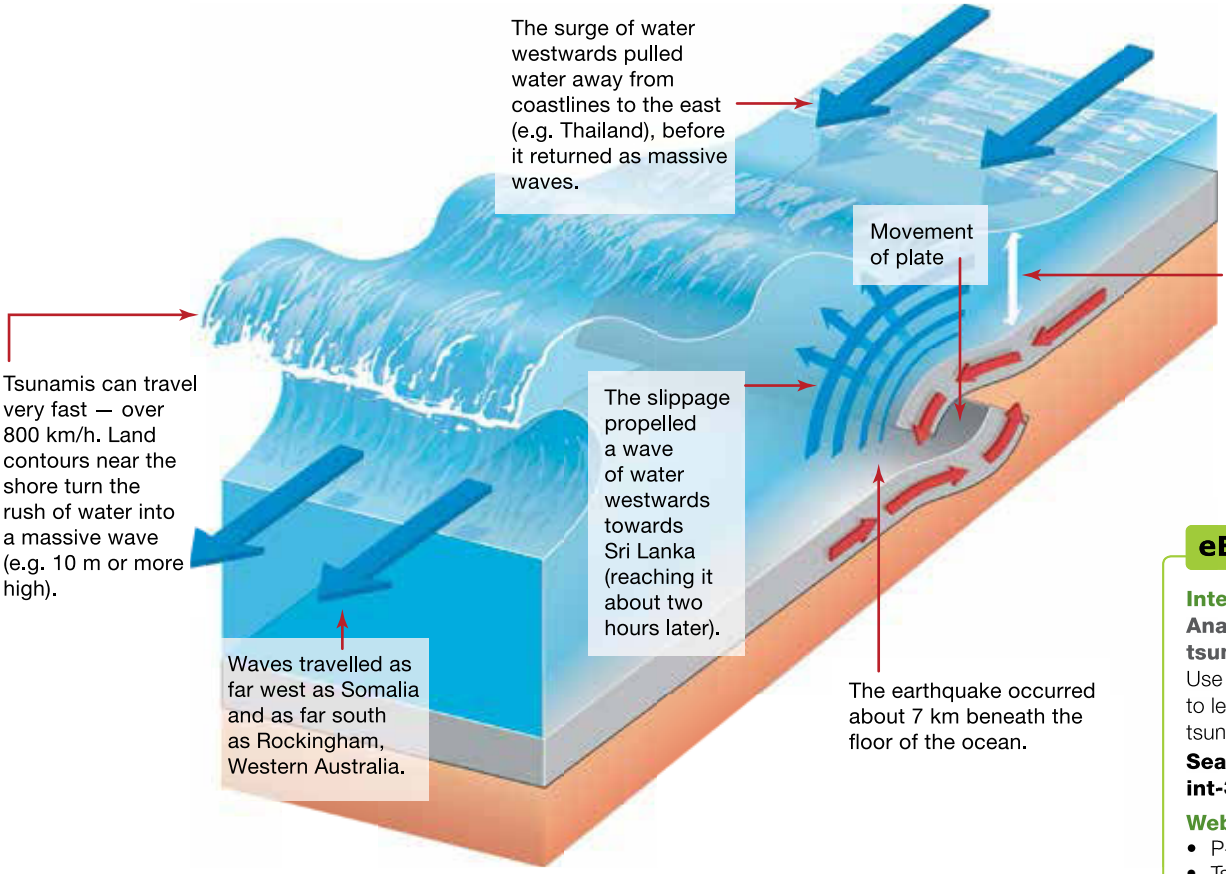
Source: Spatial Vision

FIGURE 6 The tsunami caused by the 8.9-magnitude earthquake in March 2011 swept across Sendai Airport in Japan, carrying debris with it.



A tsunami is not a single wave. There may be between five and twenty waves altogether. Sometimes the first waves are small and they become larger; at other times there is no apparent pattern. Tsunami waves will arrive at fixed periods between ten minutes and two hours.

FIGURE 7 The earthquake and subsequent tsunami in the Indian Ocean in 2004 occurred along the boundary between tectonic plates.



eBook*plus*

Interactivity
Anatomy of a tsunami
Use this interactivity to learn about how tsunamis form.
Searchlight ID: int-3111

Weblinks
- P- and S-waves
- Tsunami animation
- World's biggest tsunami

ACTIVITIES

IDENTIFY
1 What is the focus and epicentre of an earthquake?
2 How does an earthquake occur?
3 What does the Richter scale measure? How much more powerful is the magnitude of an earthquake at 7.0 than at 5.0?
4 Which plates are located in the New Zealand region?

EXPLAIN
5 Use the **P- and S-waves** weblink in your eBookPLUS to watch an animation of these waves. What is the difference between the waves? How fast do they travel? How is damage caused by the waves?
6 Study the **Tsunami animation** weblink in your eBookPLUS, and figure 7. Use your own words to explain how a tsunami occurs.

APPLY
7 Use an atlas or Google Earth to find the location of Lituya Bay. Draw a map to show the location. Use the **World's biggest tsunami** weblink in your eBookPLUS to listen to eyewitness accounts of the event. How does this help give you a sense of the ***scale*** of this event?
8 Study figure 4. Describe where the most violent shaking occurred as a result of the earthquake. How many plates meet in this region? What impact does this have?
9 Study figure 5.
- **a** Where in Japan was the greatest intensity felt?
- **b** What is the population density for Sendai, Tokyo and Niigata? How would this increase the impact of the earthquake?

PREDICT
10 Study the photo of the Japanese tsunami in figure 6.
- **a** Imagine you are a radio news reporter. Describe what you see and what might be happening to people in the area.
- **b** Imagine you were a Sendai resident. Describe what you would have done to take care of yourself.

11 Why would most Australians not know what to do if an earthquake occurred?

5.7 What are the impacts of earthquakes and tsunamis?

5.7.1 Impacts of earthquakes and tsunamis

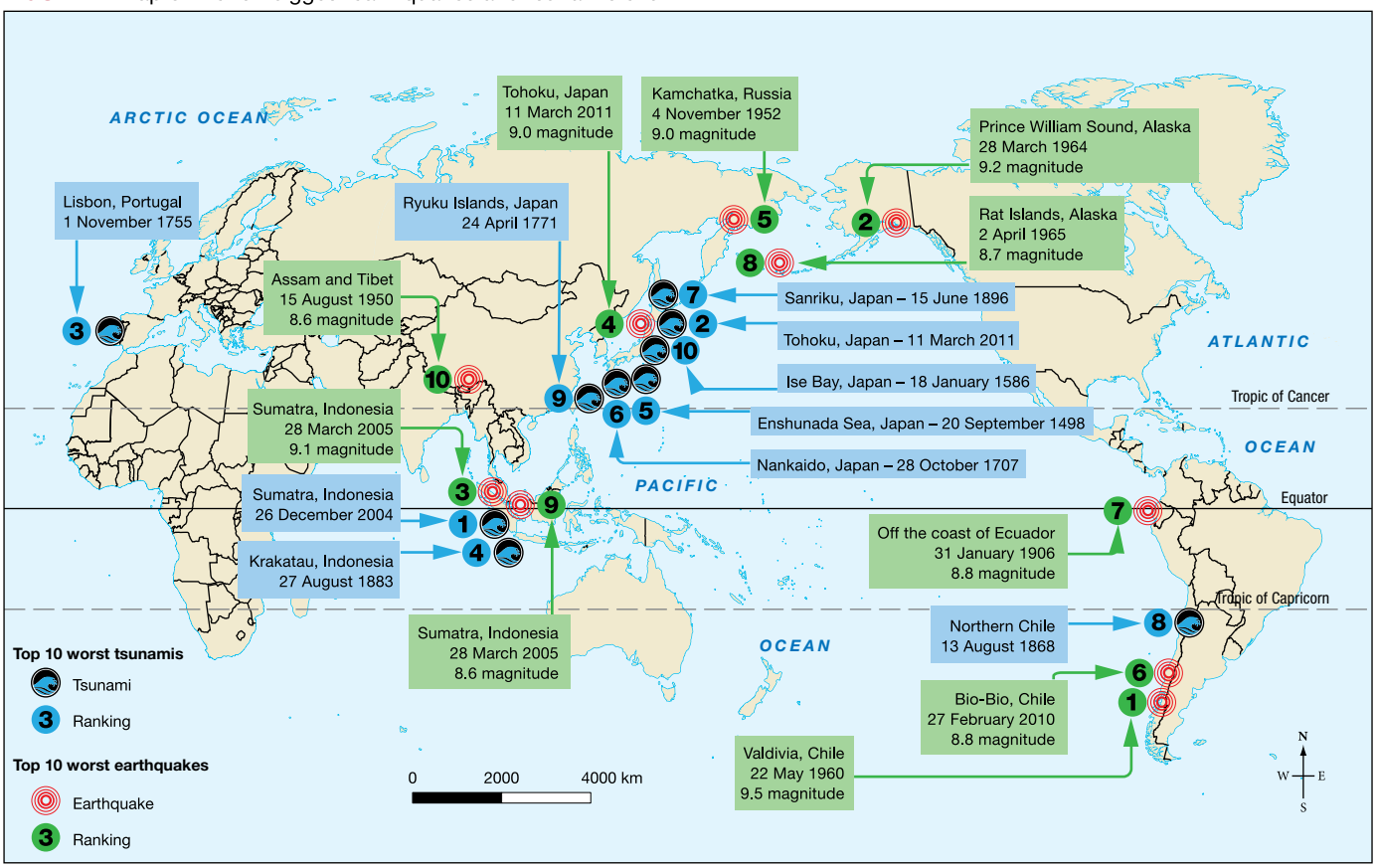
Earthquakes and tsunamis can have an enormous impact. The degree of impact can be affected by several factors: the size of the quake; its location; the density of the population near the epicentre; and whether there are any densely populated areas nearby. Poverty also plays a role, because it can increase the vulnerability of a country or region to such disasters. Measuring the event by the impact can be difficult. Should it be measured by the number of people killed and made homeless (social impact); the cost of recovery (economic impact); or the effect on the surroundings (environmental impact)?

5.7.2 Impact on people

The data in the map in figure 1, and in tables 1 and 2, show some of the worst earthquake and tsunami disasters that have occurred. The amount of damage and death they cause does not always relate to the magnitude of the earthquake. Some smaller magnitude earthquakes can have a devastating impact. Likewise, to measure the impact of a tsunami, we have to look at its effect on people, not at the magnitude of the earthquake (or volcano) that caused it, and not at the size of the waves, which are difficult to measure.

Less developed countries often do not have the resources to prepare adequately for an earthquake. Often, many people are housed in badly constructed buildings in densely populated areas on poor land which does not withstand an earthquake or tsunami event. When a disaster strikes, poorer countries often do not have the resources to act quickly and get help for relief efforts.

FIGURE 1 Map of the ten biggest earthquakes and tsunamis ever



Source: Spatial Vision

TABLE 1 Tsunamis shown in figure 1

Number on map and cause of tsunami	Description and impact
1. 9.1 earthquake, Sumatra, Indonesia	Tsunami 50 m high, reaching 5 km inland near Meubolah. 230 000 people died. Estimated damages of US$10 billion.
2. 9.0 earthquake, Tohoku, Japan	Tsunami waves of 10 m swept over the east coast of Japan. 19 000 people died. Caused nuclear emergency at Fukushima Daiichi nuclear power plant. $235 billion damages.
3. 8.5 earthquake, Lisbon, Portugal	Waves up to 30 m high struck towns along western Portugal and southern Spain. Earthquake and tsunami killed 60 000 in Portugal, Morocco and Spain.
4. Volcano, Krakatau, Indonesia	Tsunami linked to the explosion of the Krakatau volcano. Waves as high as 37 m demolished the towns of Anjer and Merak. Killed 40 000 people, with 2000 deaths caused by the volcanic eruptions rather than the tsunami.
5. 8.3 earthquake, Enshunada Sea, Japan	Homes were flooded and swept away; 31 000 people killed.
6. 8.4 earthquake, Nankaido, Japan	Waves up to 25 m high struck the Pacific coasts of Kyushyu, Shikoku and Honshin. Nearly 30 000 buildings were damaged in the affected regions and about 30 000 people were killed.
7. 7.6 earthquake (estimated), Sanriku, Japan	Tsunami was reported to have reached a height of 38.2 m, causing damage to more than 11 000 homes and killing around 22 000 people. Reports were also found of a corresponding tsunami hitting the east coast of China, killing around 4000 people and doing extensive damage to local crops.
8. Two 8.5 earthquakes, Northern Chile	Waves up to 21 m high affected the entire Pacific Rim for two or three days. Tsunami registered by six tide gauges as far away as Sydney, Australia. 25 000 deaths and estimated damages of US$300 million were caused along the Peru–Chile coast.
9. 7.4 earthquake, Ryuku Islands	Tsunami waves around 11–15 m high destroyed 3137 homes, killing nearly 12 000 people in total.
10. 8.2 earthquake (estimated), Ise Bay, Japan	Waves of 6 m caused more than 8000 deaths and a large amount of damage to a number of towns.

TABLE 2 Earthquakes shown in figure 1

Number on map and magnitude of earthquake	Description and impact
1. 9.5, Valdivia, Chile	Killed 1655 people, injured 3000 and displaced two million. Caused US$550 million damage. Two days later, Puyehue volcano erupted, sending ash and steam into the atmosphere for several weeks.
2. 9.2, Prince William Sound, Alaska	Resulting tsunami killed 128 people and caused US$311 million in damage.
3. 9.1, Sumatra, Indonesia	Killed 227 900 people, displaced 1.7 million in South Asia and East Africa. On 28 December, a mud volcano began erupting near Baratang, Andamar Islands.
4. 9.0, Tohoku, Japan	Earthquake caused tsunami that killed 19 000 people, injured 6000. Caused US$ tens of billions. Economic impacts huge, especially with the shutting down of a nuclear reactor.
5. 9.0, Kamchatka, Russia	Generated a tsunami that caused damage of US$1 million in Hawaiian Islands. Some waves over 9 m high at Kaena Point, Oahu. None killed.
6. 8.8, Bio-Bio, Chile	Killed at least 521 people, with 56 missing and 12 000 injured. More than 800 000 people displaced, with a total of 1.8 m people affected across Chile, where damage was estimated at US$30 billion.
7. 8.8, off the coast of Ecuador	Earthquake caused tsunami reported to have killed between 500 and 1500 people in Ecuador and Colombia.
8. 8.7, Rat Islands, Alaska	Generated a tsunami about 10 m high that caused damage on Shemya Island, plus US$10 000 in property damage from flooding on Amchitka Island. No deaths or injuries reported.
9. 8.6, Sumatra, Indonesia	Killed 1313, with more than 400 people injured by the tsunami as far away as Sri Lanka.
10. 8.6, Assam and Tibet	This inland earthquake caused widespread damages to buildings as well as large landslides. 780 people were killed in eastern Tibet.

Developed countries have strict building codes and better infrastructure to withstand disasters. They have warning systems and better communication. Usually, help is quick to arrive, with army and police personnel sent in to help with rescue efforts.

A study conducted by the Swedish Red Cross concluded that:

> when one compares the number of people killed per disaster against the income of the country involved, one finds a steep rise in mortality with decreasing income. There are over 3000 deaths per disaster in low-income countries compared with fewer than 500 per event in high-income countries.

5.7.3 Impact on the environment

The impact of an earthquake or tsunami on a human environment can be catastrophic. It can damage and destroy entire settlements. **Landslides** can be triggered by earthquakes, permanently changing the landscape.

landslide a movement of rock, debris or earth down a steep slope (for example a mountain or cliff)

Liquefaction

Liquefaction occurs when soil suddenly loses strength and, mixed with groundwater, behaves like a liquid. This usually occurs as a result of ground shaking during a large earthquake. The types of soils that can liquefy include loose sands and silts that are below the water table, so all the space between the grains is filled with water. Dry soils above the water table will not liquefy.

liquefaction a process whereby the shaking of an earthquake reduces or converts soil to liquid

Once a soil liquefies, it cannot support the weight of dry soil, roads, concrete floors and buildings above it. The liquefied soil comes to the surface through cracks, and widens them.

FIGURE 2 This landslide was caused by an earthquake in June 2008 in Honshu, Japan.



FIGURE 3 Cars are swallowed by liquefied soil on a road in Christchurch, New Zealand, 2011



ACTIVITIES

IDENTIFY

1 List the different impacts that earthquakes and tsunamis can have in the categories of social, environmental and economic impacts.

EXPLAIN

2 What is the relationship between income and disaster risk? Why is the risk of earthquakes and tsunamis higher in poor countries?

3 What is liquefaction? Why does it occur? Use the **Liquefaction** weblink in your eBookPLUS to view a video of liquefaction occurring in Tokyo, Japan.

4 'The strongest earthquakes result in the worst disasters.' Work in pairs or groups of three to agree, partially agree, or disagree with this statement. Use the data on these pages and particular examples to justify your response.

INVESTIGATE

5 Use the **Sendai tsunami** weblink in your eBookPLUS to look at satellite images showing areas before and after the 2011 Japanese tsunami. Choose two locations to draw sketches of before and after, and annotate your sketches to record the ***changes*** that have taken place.

eBookplus

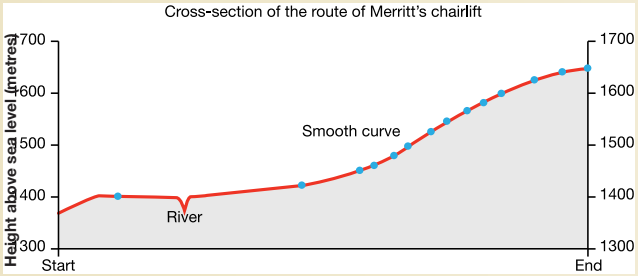
Weblinks
- Liquefaction
- Sendai tsunami

eBookplus ONLINE ONLY

5.8 SkillBuilder: Drawing a simple cross-section

What are cross-sections?

A cross-section is a side-on, or cut-away view of the land, as if it had been sliced through by a knife. Cross-sections provide us with an idea of the shape of the land. We can use contour lines on topographic maps to draw a cross-section between any two points.



eLesson

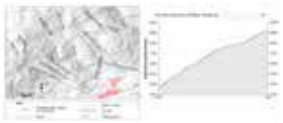
Watch this video to learn how to draw a simple cross-section.



Searchlight ID: eles-1655

Interactivity

Try this interactivity to learn how to draw a simple cross-section.



Searchlight ID: int-3151

eBookplus ONLINE ONLY

5.9 SkillBuilder: Interpreting an aerial photo

What are aerial photos?

Aerial photographs are those that are taken from above the Earth from an aircraft. Aerial photos can reveal details that are not recorded on maps. It is easy to see landforms with distinct shapes, different landscapes, land uses, specific places and spatial patterns of the environment.



eLesson

Watch this video to learn how to interpret an aerial photo



Searchlight ID: eles-1654

Interactivity

Try this interactivity to learn how to interpret an aerial photo.



Searchlight ID: int-3150

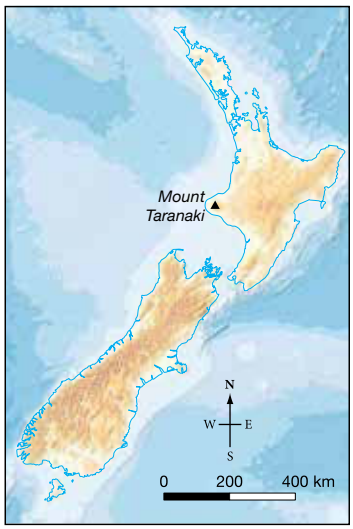
eBookplus ONLINE ONLY

5.10 How are volcanic mountains formed?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

5.11 How did Mount Taranaki form?

FIGURE 1 Location of Mt Taranaki on the North Island of New Zealand



Source: Spatial Vision

5.11.1 Mount Taranaki

New Zealand's Mt Taranaki is named after the Maori terms *tara* meaning 'mountain peak' and *ngaki* meaning 'shining' (because the mountain is covered with snow in winter).

Mt Taranaki is 2518 metres high and is the largest volcano on New Zealand's mainland. It is located in the south-west of the North Island (see figure 1).

Mt Taranaki was formed 135 000 years ago by subduction of the Pacific Plate below the Australian Plate. It is a stratovolcano — a conical volcano consisting of layers of pumice, lava, ash and tephra (see figure 2).

The summit of Mt Taranaki is a lava dome in the middle of a crater that is filled with ice and snow. The mountain is considered likely to erupt again. There are significant potential hazards from lahars, avalanches and floods. A circular plain of volcanic material surrounding the mountain was formed from lahars (see section 5.12, annotation I) and landslides. Some of these flows reached the coast in the past. The volcano's lower flanks are covered in forest, and are part of the national park. There is a clear line between the park boundary and surrounding farmland (see figure 3).

FIGURE 2 Mt Taranaki has a near-perfect conical shape.



FIGURE 3 Aerial photo of Mt Taranaki



eBook*plus*

Weblink
Mt Taranaki live

GEOskills TOOLBOX

Understanding contour lines

Contour lines are used on topographic maps to show height about sea level. Each line joins points at the same elevation. This helps to show the shape of the land and patterns of landforms. If contour lines are very close, the land is steep. If the contour lines are further apart, there is more of a gradual slope.



ACTIVITIES

IDENTIFY

1 Where is Mt Taranaki located?
2 What is a stratovolcano?
3 Refer to figure 4.
  a What is the grid reference for the spot height of Mt Taranaki?
  b How many ski tows and lifts are there at the ski field? Calculate the length of each.
  c Name and give the grid reference of a lodge in which skiers could stay.

EXPLAIN

4 Mt Taranaki receives between 3200 mm and 6400 mm of rainfall each year. How would this contribute to the shape of this landform?
5 Describe evidence from the aerial photo in figure 3 that the national park has protected forests around the volcano.

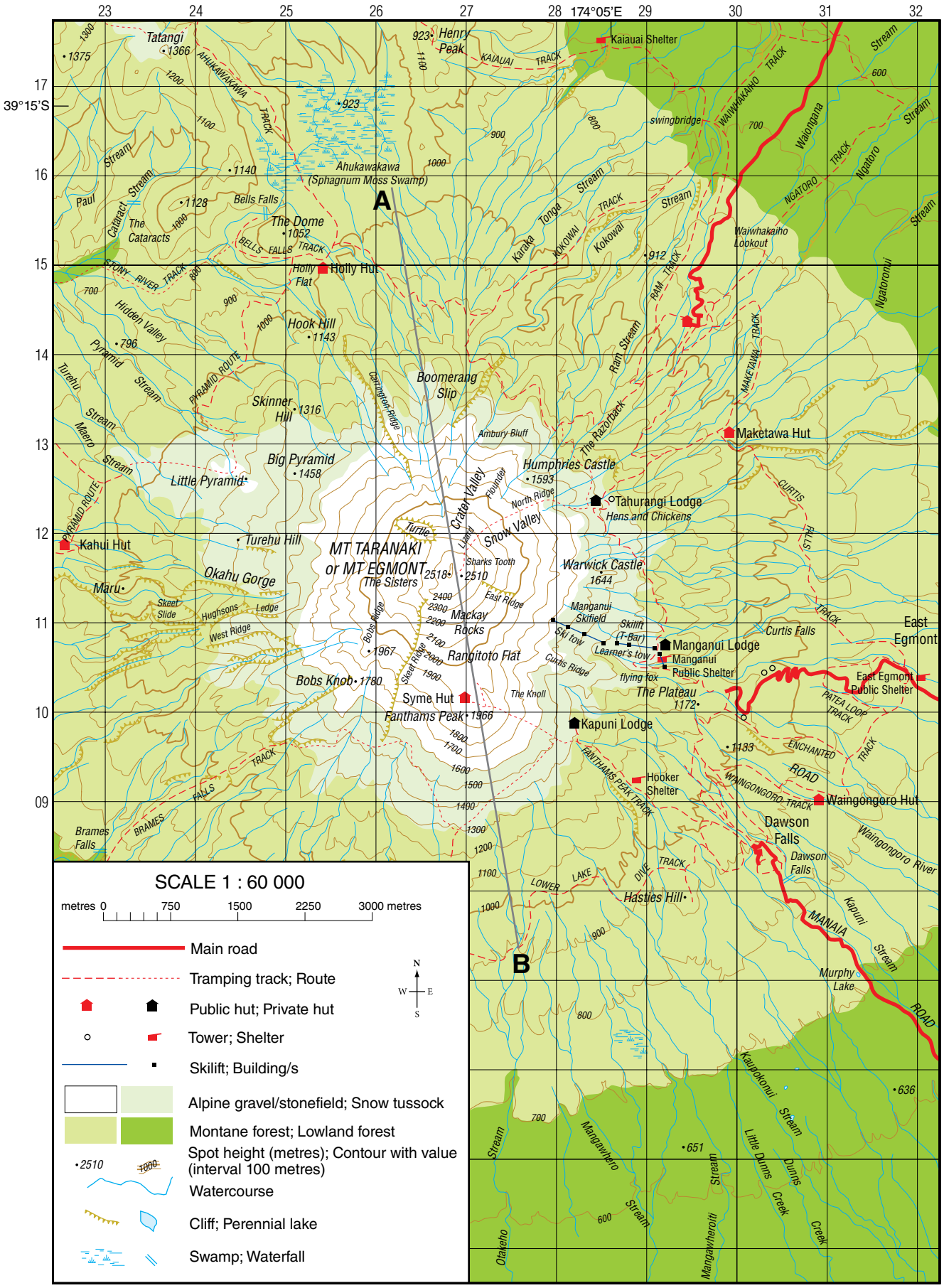
INVESTIGATE

6 Use the **Mt Taranaki live** weblink in your eBookPLUS to view Mt Taranaki using the webcam.

APPLY

7 Refer to figure 4 to complete the following.
  a Use the line already drawn on the topographic map to draw a cross-section. (See SkillBuilder 5.8 'Drawing a simple cross-section' in your eBookPLUS.)
  b Calculate the gradient from point A to the summit.
  c Calculate the gradient from point B to the summit.
8 a Use figures 2 and 3, together with your cross-section from question 7a, to describe where you think lava would flow if Mt Taranaki erupted.
  b Describe the potential ***changes*** to the human and natural ***environment*** if Mt Taranaki erupted.

FIGURE 4 Topographic map of Mt Taranaki



Source: MAPgraphics Pty Ltd Brisbane

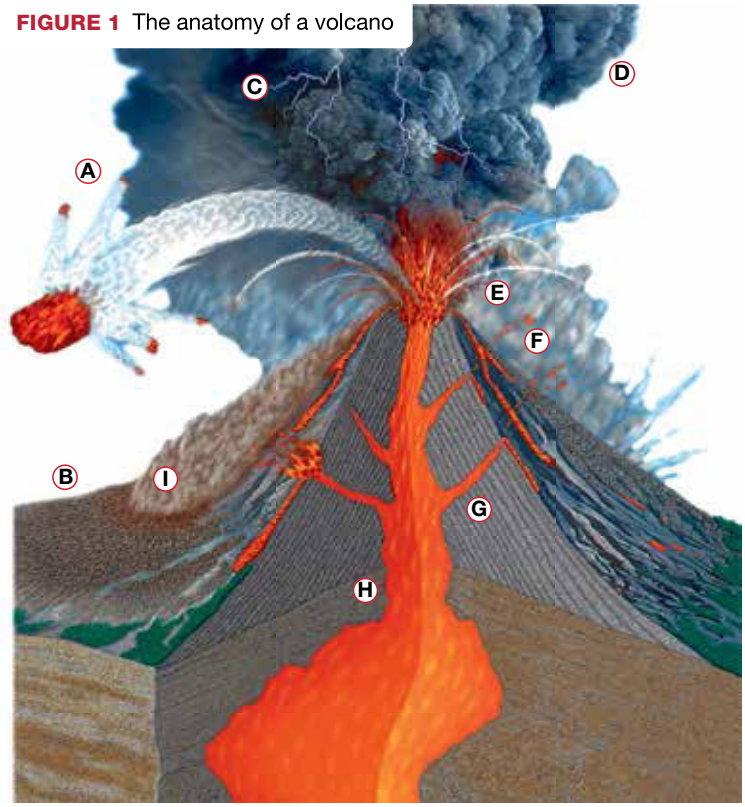
5.12 What is the anatomy of a volcano?

5.12.1 Volcanic eruptions

Volcanic mountains are formed when magma pushes its way to the Earth's surface and then erupts as lava, ash, rocks and volcanic gases. These erupting materials build up around the vent through which they erupted.

A volcanic eruption can be slow or spectacular, and can result in a number of different displays (see figure 1).

FIGURE 1 The anatomy of a volcano



Ⓐ A fragment of lava greater than 64 millimetres in diameter is called a volcanic bomb. They are often solid pieces of lava from past eruptions that formed part of the cone.

Ⓑ A pyroclastic flow is a superheated avalanche of rock, ash and lava that rushes down the mountain with devastating effects. The flow can travel at up to 240 kilometres per hour and reach temperatures of 800 °C. When Mt Pelée erupted in 1902, on the island of Martinique in the Caribbean, a pyroclastic flow covered the town of Saint-Pierre, killing all but two of the town's 30 000 inhabitants.

Ⓒ Lightning is often generated by the friction of swirling ash particles.

Ⓓ As rock is pulverised by the force of the eruption, it becomes very fine ash, and is carried by wind away from the crater as an ash cloud. Volcanic ash may blanket the ground to a depth of many metres. In the eruption of Mt Vesuvius in AD 79, volcanic ash completely covered two large towns: Pompeii and Herculaneum. Volcanic ash can also have a large impact on the global scale because of disruption to international air traffic, as seen during volcanic eruptions in Indonesia in 2015.

Ⓔ A volcanic cone is made up of layers of ash and lava from previous eruptions. If the volcano has not erupted for thousands of years (i.e. is dormant), these layers will be eroded away.

Ⓕ Lava may be either runny or viscous, and can flow for many kilometres before it solidifies, thereby building up the Earth's surface.

Ⓖ Pressure may force magma through a branch pipe or side vent. In the eruption of Mount St Helens in 1980, in the United States, the side of the mountain collapsed and the side vent became the main vent.

Ⓗ Where two plates move apart, molten rock from the mantle flows upward into a magma chamber. More rock is melted and erupts violently upwards. Magma is generally within the temperature range of 700 °C to 1300 °C.

Ⓘ When pyroclastic flows melt snow and ice, and mix with rocks and stones, a very wet mixture called a lahar can form. Lahars can flow quickly down the sides of volcanoes and cause much damage (see subtopic 4.8 for an example of a lahar). One lahar that formed in 1985 on Nevado del Ruiz volcano in Colombia travelled at up to 50 km/h and was up to 40 metres high in some places. A wall of mud, water and debris travelled 73 kilometres to the town of Armero, devastating it. Over 23 000 people died that night, and 5000 homes were destroyed.

5.12.2 Volcanic shapes

Volcanoes come in a variety of shapes and sizes, forming different landforms. There are four main types and each depends on:

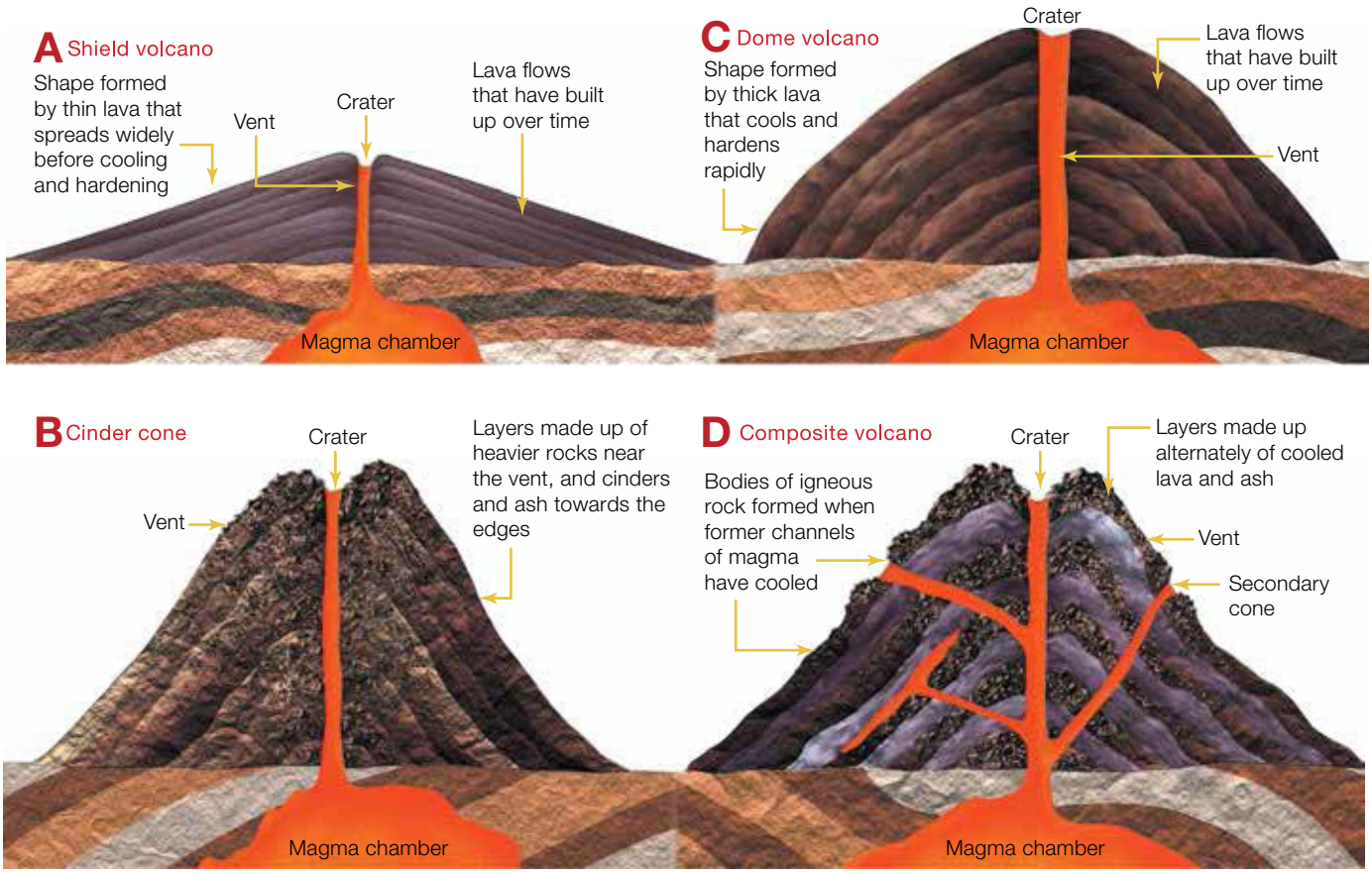
- the type of lava that erupts
- the amount and type of ash that erupts
- the combination of lava and ash.

If the lava is rich in silica (a mineral present in sand and quartz), it tends to be very runny and may flow for many kilometres before it cools and hardens to become rock. Volcanoes that erupt runny lava tend to have broad, flat sides (shield volcanoes). Those that erupt thick, treacle-like lava tend to have much steeper sides (dome volcanoes)(see figure 2, parts A and C).

Heavy ash material, like volcanic bombs, settles close to the crater while lighter ash is carried further away. Volcanoes that are built up through falls of ash are steep-sided cinder cones (see figure 2, part B).

The most common type of volcano is one built up of both ash and lava; this is called a composite volcano (see figure 2, part D).

FIGURE 2 Four volcanic landforms



ACTIVITIES

IDENTIFY

1 What are the three main factors that determine the shape of a volcano?

EXPLAIN

2 Explain how the different shapes of volcano shown in figure 2 are the results of different materials being ejected.

3 a Refer to figure 1. Describe, in detail, the ***changes*** to the ***environment*** that volcanic eruptions can cause.

b Which ***changes*** would impact on a small ***scale*** and which would impact on a larger ***scale***?

PREDICT

4 Investigate how to create a working model of a volcano, choosing one of the four main shapes to copy. Predict what will happen when your volcano erupts. Create your volcano, and observe what happens when it erupts. Compare your observations with your earlier predictions, describing the similarities and differences.

INVESTIGATE

5 Use the internet to find pictures of volcanic landforms and materials. These include crater lakes, geysers, calderas, fields of ash deposits, volcanic plugs, lava tubes, hummocks and pumice. You could also find pictures of the two types of lava: a'a and pahoehoe. Use your pictures to put together a field guide to volcanic landforms. Each page should contain a picture of the landform, a brief description and a ***place*** where it could be found — sometimes they are tourist attractions.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Lahars

5.13 How do volcanoes affect people?

5.13.1 The worst volcanic eruptions

Volcanic eruptions both create and destroy landscapes. Most volcanic eruptions do not strike randomly but occur in specific areas, such as along plate boundaries. In some ***places*** there are high concentrations of people living near volcanoes.

Most of the world's active above-sea volcanoes are located near convergent plate boundaries where subduction is occurring, particularly around the Pacific basin. This is also the location of settlements across many countries. Over many years, volcanic eruptions have caused deaths and great damage.

How can the worst volcanoes be measured? Should it be based on the number of people killed or the cost of the damage and destruction? Or should it be the size of the explosion?

TABLE 1 The worst volcanoes based on number of deaths

Volcano	Location	Date	Number of deaths
Mt Tambora	Indonesia	10–5 April 1816	92 000
Mt Pelee	West Indies	25 April–8 May 1902	40 000
Krakatau	Indonesia	26–28 August 1883	36 000
Nevado del Ruiz	Colombia	13 November 1985	23 000
Mt Unzen	Japan	1792	12 000–15 000
Mt Vesuvius	Italy	24 April AD 79	10 000+
Laki Volcanic System	Iceland	8 June 1783–February 1784	9 350
Mt Vesuvius	Italy	December 1631	6 000
Mt Kelut	Indonesia	19 May 1919	5 110
Mt Galunggung	Indonesia	1882	4 011

TABLE 2 The worst volcanoes based on economic impact

Volcano	Location	Date	Estimated loss (US$)
Sidoarjo mud volcano (Lusi)	Indonesia	May 2006, ongoing	$3 billion
Mt Eyjafjallajökull	Iceland	April 2010	$1.7 billion
Mt Unzen	Kyushu, Japan	June 1991	$1.5 billion
Mt St Helens	USA	May 1980	$860 million
Mt Pinatubo	Philippines	June–September 1991	$860 million
Soufrière Hills	Montserrat	Since 1995	$330 million
Tavuvur and Vulcan	Papua New Guinea	September 1994	$300 million
Nevado del Ruiz	Colombia	November 1985	$230 million
Eldfell	Iceland	January–February 1973	$200 million
Gamalama	Indonesia	September 1983	$150 million

5.13.2 Why do people live near volcanoes?

Geoscience Australia (a national organisation that provides geographic information to government) estimates that 180 million people in the Asia–Pacific region live within 50 kilometres of a dangerous volcano. There is also a strong relationship between the location of volcanoes and resources such as fertile soils, ore deposits and geothermal energy.



FIGURE 1 Agriculture and settlement near Mayon Volcano in the Philippines

Fertile soils

Some of the most fertile soils on Earth have come from volcanic deposits of ash that is rich in nutrients, and from the physical breakdown of volcanic rocks over thousands to millions of years.

Fertile volcanic soils have been very important for rice growing in Japan and large areas of the Indonesian archipelago, especially on the islands of Java and Bali. There is also prime agriculture located in regions of rich soil; for example, around Naples, southern Italy, which generally has poor soils, and in the Philippines as shown in figure 1.

Another region of fertile volcanic soil is the agricultural area of the North Island of New Zealand. **Volcanic loam** in this area helps produce crops and pasture. Other regions include the western plains of the United States and the Hawaiian Islands. There is a small percentage of rich basalt soils in Australia, including the volcanic plains in Victoria, the north coast of New South Wales, the Scenic Rim of south-east Queensland, parts of Tasmania, and the Atherton Tablelands in north Queensland.

volcanic loam
nutrient-rich soil derived from volcanic ash deposits

Geothermal energy

Geothermal energy can be used in locations where there are active or dormant volcanoes still producing heat deep under the Earth's surface. High-temperature hot springs and geysers produce steam, which can be used to drive turbines and generate electricity. At lower temperatures, the hot water can be used for home heating or to develop hot or warm springs at resort spas. Over one quarter of Iceland's electricity is generated from geothermal heat, and it provides heating for more than 85 per cent of its homes. The other main countries that make use of geothermal heat are the United States (in California), Italy, New Zealand and Japan.

geothermal energy
energy derived from heat in the Earth's interior



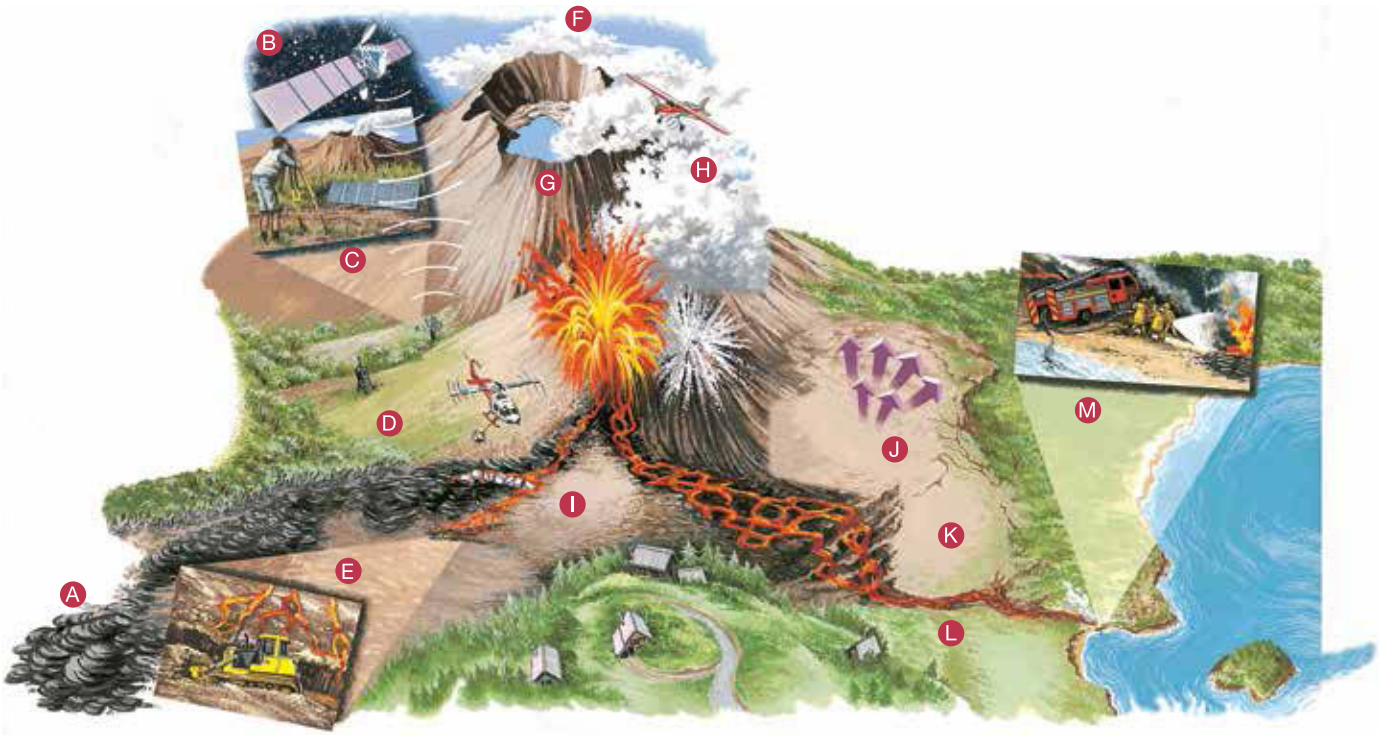
FIGURE 2 Volcanic landscapes provide us with a range of economic and cultural values. Heated water from 2000 metres below the surface is pumped up through drilling holes at a geothermal power plant in Svartsengi, Iceland. It is used to generate electricity and hot water for nearby communities. The 38 °C waters are then fed into a man-made lagoon for recreational and medicinal users to bathe in. The Blue Lagoon is one of Iceland's most popular tourist destinations.

5.13.3 How to prepare for volcanic eruption

Can volcanic eruptions be predicted? What are the warning signs? How can the risk of death, injury and damage be reduced?

With about 500 million people living close to active volcanoes, it is important to watch for ***changes*** and try to predict an eruption, hopefully giving nearby residents time to evacuate.

FIGURE 3 Predicting volcanic eruptions



- **A** Geologists study records of past eruptions by examining flow patterns of mud, lava and ash. From these patterns they can draw danger maps that pinpoint dangerous areas.
- **B** Satellites monitor changes in gas emissions and in the shape of the volcano. Specialised equipment can also measure heat increases.
- **C** Seismographs can detect the small earthquakes caused by rising magma. These are linked by transmitters to computers so that scientists can quickly detect changes.
- **D** Sound-measuring equipment was used to accurately predict an eruption in Mexico in 2000.
- **E** In 1983, an attempt was made to divert a lava flow away from the towns of Rocco and Rogalna on Mount Etna. A channel was dug and barriers erected. The lava slowed and solidified before reaching the towns.
- **F** Samples of gas can be collected and analysed. An increase in the amount of sulfur dioxide [SO_2] may indicate that magma is moving upwards.
- **G** A rise in the temperature of a crater lake often precedes an eruption.
- **H** It has been suggested that explosives could be used to breach crater walls, sending lava away from towns. This was first tried in Hawaii in 1935.
- **I** Helicopters have been used to drop concrete blocks in front of flowing lava.
- **J** As magma rises and collects in the magma chambers, the cone may bulge outwards, warning of possible eruptions. Sensitive tiltmeters on the ground and on satellites can detect this bulging.
- **K** Any bulging can also cause tiny cracks to appear.
- **L** Buildings in areas prone to ash eruptions should have steeply sloping roots so ash does not accumulate.
- **M** In 1973, sea water was sprayed onto lava that was threatening a town in Iceland. The lava cooled quickly and solidified.

People living in volcanically active regions are frequently provided with advice about how they should respond to volcanic eruption. Local authorities give information on what to do to prepare for a possible volcanic eruption, how to evacuate and what to do after an eruption (see figure 4).

FIGURE 4 Example of advice provided to people living near volcanoes

Before a volcanic eruption

- Prepare an emergency kit with items such as: a first aid kit; blankets and warm clothing; a torch; a working battery-operated radio; goggles and a mask; medications; a map of the local area.
- Store food and water supplies.
- Review and know your evacuation route or routes.
- Develop a household evacuation and preparedness plan.

During and after a volcanic eruption

- Seek shelter indoors. Once inside, close windows and doors. Block chimneys and other vents, to stop volcanic ash entering the house.
- Turn off any heating and fans as well as air conditioning systems.
- Move to high ground only if you can't find shelter.
- Wear long-sleeved shirts and long pants.
- Avoid exposure to poisonous gases.
- Remain indoors until you are told that it is safe to come out.
- Evacuate only if advised to do so by authorities.
- Stay clear of lava, mud flows, and flying rocks and debris.

ACTIVITIES

IDENTIFY

1 Make a list of the advantages and disadvantages of living near a volcano.

EXPLAIN

2 Is geothermal energy a renewable energy? Explain. How is this energy related to volcanic activity?

INVESTIGATE

3 Refer to an atlas map showing world population density, settlements and the location of volcanoes. Write two statements that describe the relationship between population density, settlements and volcano locations. How does this relate to people's risk?

4 Use the **Timetoast** weblink in your eBookPLUS to create a timeline of the worst volcanic eruptions, based on the information in the tables. Include images from the internet.

5 Draw a table like the one below to summarise the measures required for living with volcanoes.
- a Classify the information in figure 3 into the three columns of the table.
- b Which of these measures do you think are most effective? Give three reasons for your answer.

PREDICT

6 Watch the video about Mount Vesuvius and look at the information on this volcano in *myWorld Atlas*.
- a Where is Mt Vesuvius located? Which towns were destroyed by the volcano in AD79?
- b How many people live in this volcano's immediate region?
- c Will all the monitors provide enough warning of an eruption for the people of Naples? Explain.
- d What do the scientists in this video predict for a future eruption?
- e What is the red zone? How large do the scientists think it should be?

Predicting eruptions	Preparing for eruptions	Lessening the effects of eruptions

eBookplus
Weblink
Timetoast

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Mount Vesuvius

eBookplus ONLINE ONLY

5.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

5.8 SkillBuilder: Drawing simple cross-sections

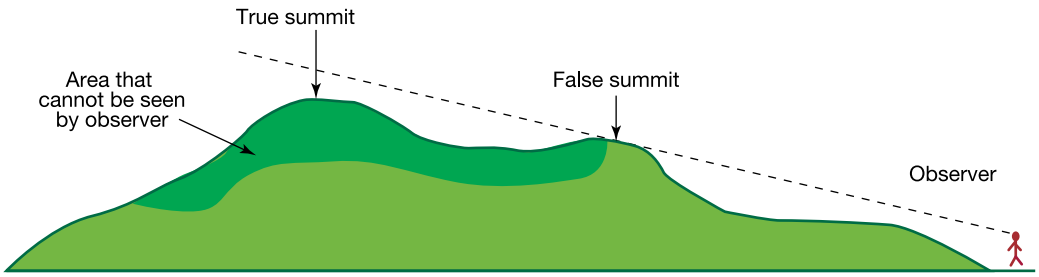
5.8.1 Tell me

What are cross-sections?

A cross-section is a side-on, or cut-away view of the land, as if it had been sliced through by a knife. It is like taking a vertical slice of the landscape and looking at it side-on. Cross-sections provide us with an idea of the shape of the land. We can use contour lines on topographic maps to draw a cross-section between any two points. Cross-sections also indicate heights at a range of points.

Why are cross-sections useful?

FIGURE 1 Working with cross-sections



Cross-sections help us visualise the shape of the land between any two points. They are useful as sometimes it is difficult to visualise what topography (shape of the land) is like when looking at a topographic map. Also, they help us determine if a landform will block the view of other landforms, for example if a high hill obscures the view of the valley beyond and the lower range of hills. Cross-sections are also useful for:

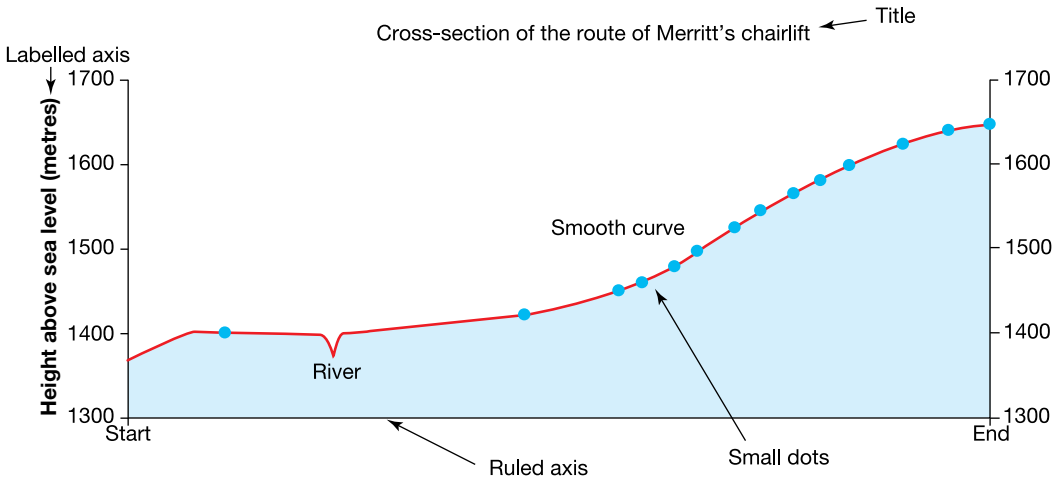
- showing the changing shape of the land
- planning a walk or hike in a mountainous area
- planning constructions, such as houses, on sloping blocks.

Model

A good cross-section has:

- been drawn in pencil
- ruled axes
- labelled axes
- used small dots
- created a smooth curve
- labelled features, if necessary
- a title.

FIGURE 2 A completed cross-section of Merritt's chairlift route



5.8.2 Show me

How to complete a cross-section

You will need:

- a topographic map of the region being considered
- a piece of paper with a straight side for marking the contours
- another sheet of paper, or graph paper, to draw the cross-section on
- a light grey pencil
- a ruler
- an eraser.

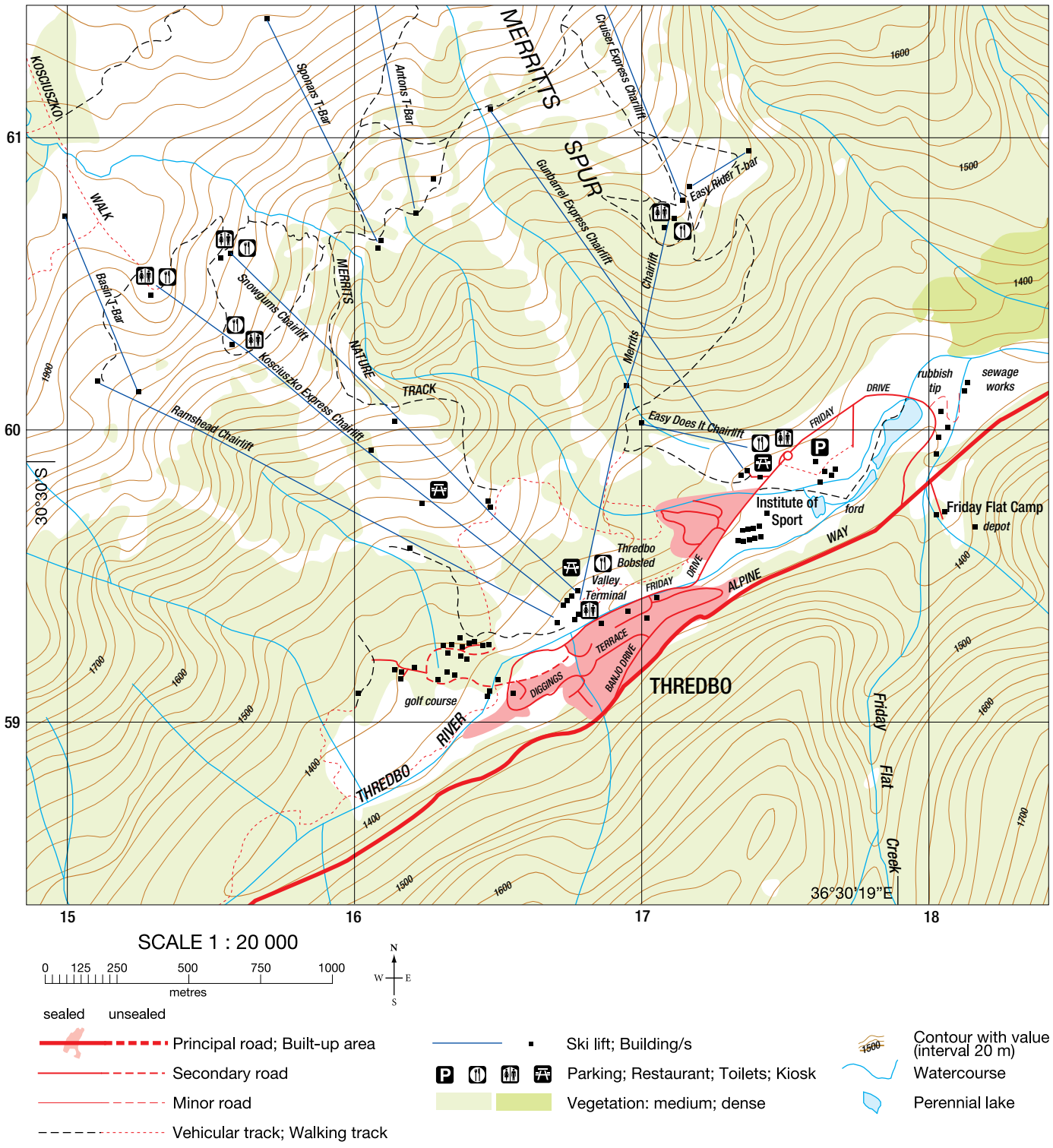
Procedure:

To complete a cross-section you must have a topographic map of the place and decide between which two points you would like to look at a cut-away view of the land.

eBookplus

eLesson
Drawing simple cross-sections
Searchlight ID: eles-1655

FIGURE 3 Topographic map of Thredbo



SCALE 1 : 20 000

0 125 250 500 750 1000 metres

N W E S

sealed unsealed

- Principal road; Built-up area
- Secondary road
- Minor road
- Vehicular track; Walking track
- Ski lift; Building/s
- Parking; Restaurant; Toilets; Kiosk
- Vegetation: medium; dense
- Contour with value (interval 20 m)
- Watercourse
- Perennial lake

Source: MAPgraphics Pty Ltd, Brisbane

STEP 1

Determine the two points between which you want to create a cross-section. Your paper edge must be long enough to go between these points.

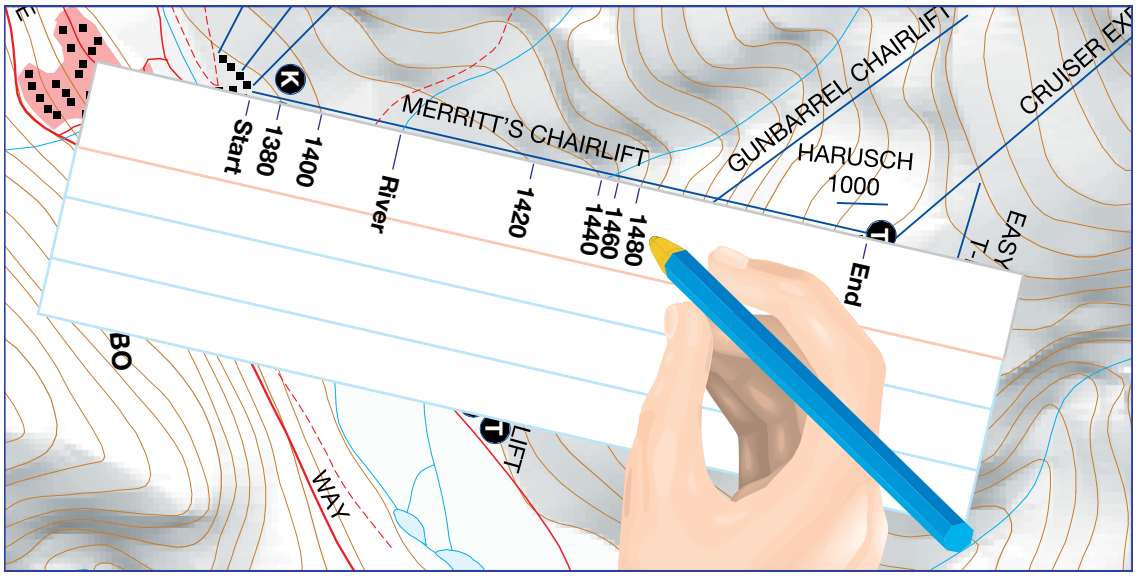
STEP 2

Place the straight edge of a piece of paper between the two points. Mark the two extremities of your cross-section on the edge. Label these 'start' and 'end' or use place names/grid references from the map.

STEP 3

Mark where each contour line touches the edge and write beside the mark on the paper the height of the contour line. It may be necessary to lift the page edge or follow the contour line to find a number. Hold your page firmly and lift the edges to prevent moving your page off the line of the cross-section. When you have completed all the contour markings you can lift the page away from the map.

FIGURE 4 Marking up the paper edge where each contour touches the page



STEP 4

On the other sheet of paper, use your ruler to draw an axis onto which to transfer your markings. The horizontal (base) line should be as long as your cross-section from 'start' to 'end'. The vertical scale needs to give a realistic impression of the slopes and landforms. For this exercise, use one centimetre to represent 100 metres.

STEP 5

Place the marked edge of the paper along the base axis. At each contour marking, find the appropriate height according to the vertical scale and put a small dot directly above the contour marked on the edge of the paper.

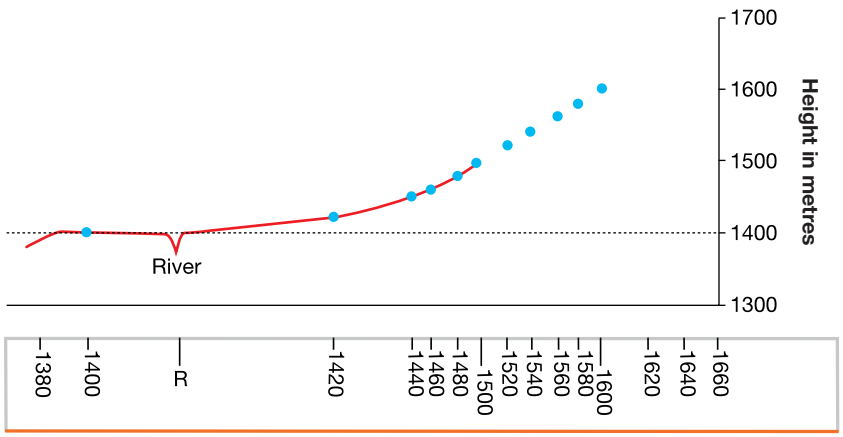
STEP 6

Join the dots with a smooth line to show the slope of the land. Notice that a notch has been used to show where a river is located on the cross-section and the river has been labelled. Other features can be marked similarly when preparing the cross-section, if required.

STEP 7

Complete the cross-section with the geographic conventions of a title and labelling of the axis. Shade the area below the line of your cross-section.

FIGURE 5 Drawing the curve of the cross-section



eBook*plus*

Interactivity
Drawing simple cross-sections
Searchlight ID: int-3151

5.8.3 Let me do it

Developing my skills

Using the 'Topographic map of Mt Taranaki' resource (doc-20635 in the Resources tab; also figure 4 in subtopic 5.11), complete a cross-section along the line A–B.

Questions

1. On your cross-section, which side of Mount Taranaki would be the easiest to walk up? Why?
2. How high is Mount Taranaki at its peak?
3. How many watercourses are shown on the cross-section?
4. Describe the vegetation cover of Mount Taranaki along the cross-section.
5. What type of land feature is Mount Taranaki?

Checklist

I have:

- used small dots
- created a smooth curve
- used pencil
- ruled the axis
- included a title
- labelled the axis.

Skills questions

1. Cross-sections are used to show:
   a. the width of a road
   b. the shape of the land between two ***places***
   c. the contours of an area
   d. how hard it is to walk in an area.
2. A cross-section includes information about:
   a. wind
   b. soils
   c. slope
   d. rainfall.
3. Why should you use small dots rather than thick pencil marks for each height on the graph?
4. Why might it be important to carefully choose the vertical ***scale***?

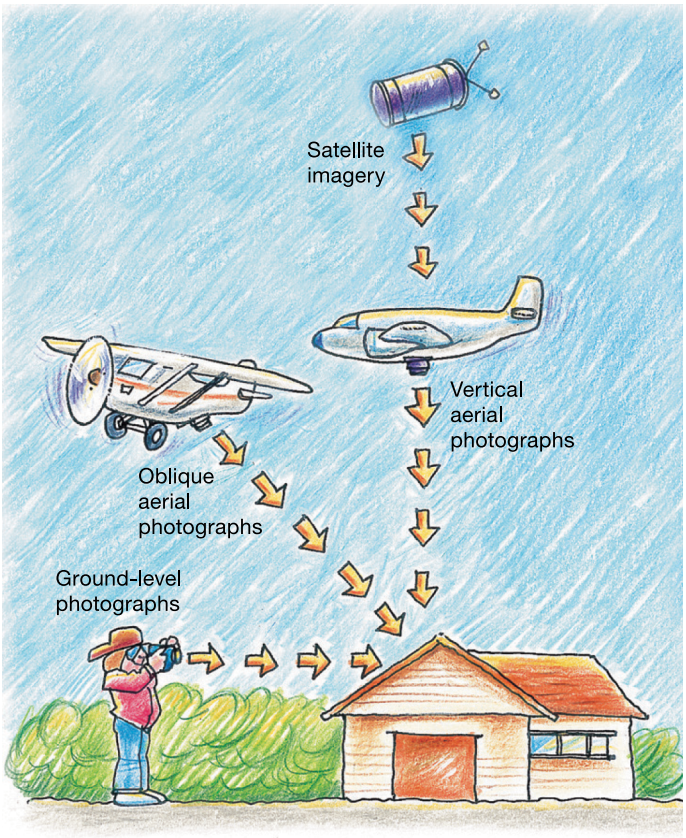
5.9 SkillBuilder: Interpreting an aerial photo

5.9.1 Tell me

What are aerial photos?

Aerial photographs are those that are taken from above the Earth from an aircraft (see figure 1). Aerial photos, either oblique or vertical, record how a place looks at a particular moment in time. Greater detail of a place can be captured than in a photo taken from ground level. Some aerial photos are also satellite compilations; that is, created by a number of images transmitted from the satellite.

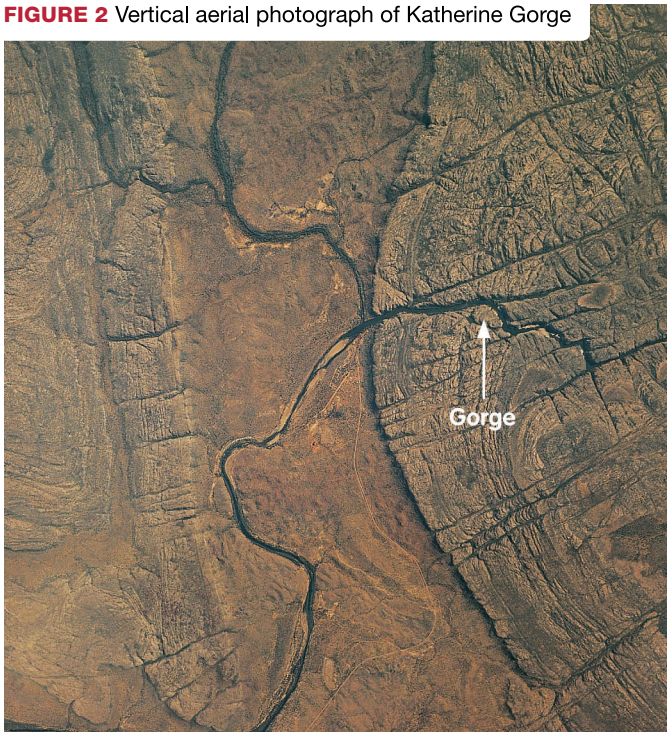
FIGURE 1 Cartographers use different types of photographs.



Vertical aerial photos are taken from directly above; that is, looking straight down on objects. Specially equipped aircraft take these photos. These photos are often referred to as a 'bird's eye' view. This is the view from which maps are drawn. When you look at one of these photos there is a similarity to a plan drawing of the place. For example, Katherine Gorge in figure 2 is so deep and narrow that it appears as a thin line 'snaking' through the rock formation.

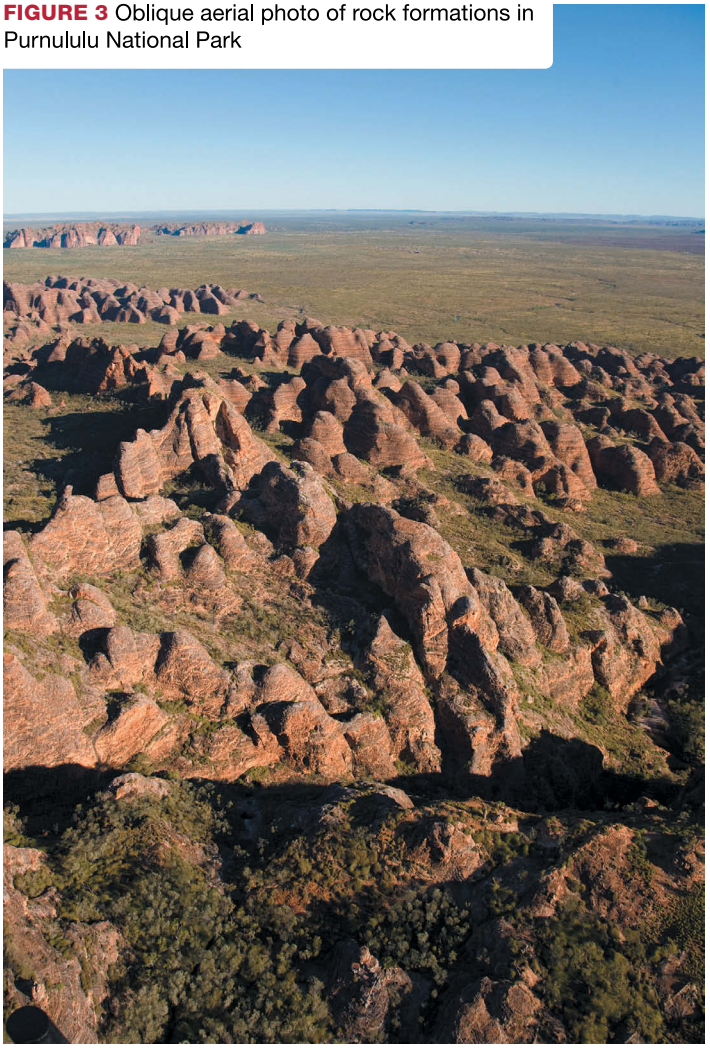
Oblique aerial photos are those taken from an angle from an aircraft. These photos show better the height and shape of objects, but some of the objects in the background can be hidden. Those objects in the foreground appear larger than those in the background. For example, in the oblique aerial photograph in figure 3 showing rock formations in Purnululu National Park in the Kimberley region of Western Australia, the sandstone domes appear larger in the foreground than in the background.

FIGURE 2 Vertical aerial photograph of Katherine Gorge



Source: © MAPgraphics Pty Ltd, Brisbane

FIGURE 3 Oblique aerial photo of rock formations in Purnululu National Park



Why are aerial photos useful?

Aerial photos can reveal details that are not recorded on maps. It is easy to see landforms with distinct shapes, different landscapes, land uses, specific places and spatial patterns of the environment. Aerial photos from different time periods can show how a place has changed over time (see figure 4).

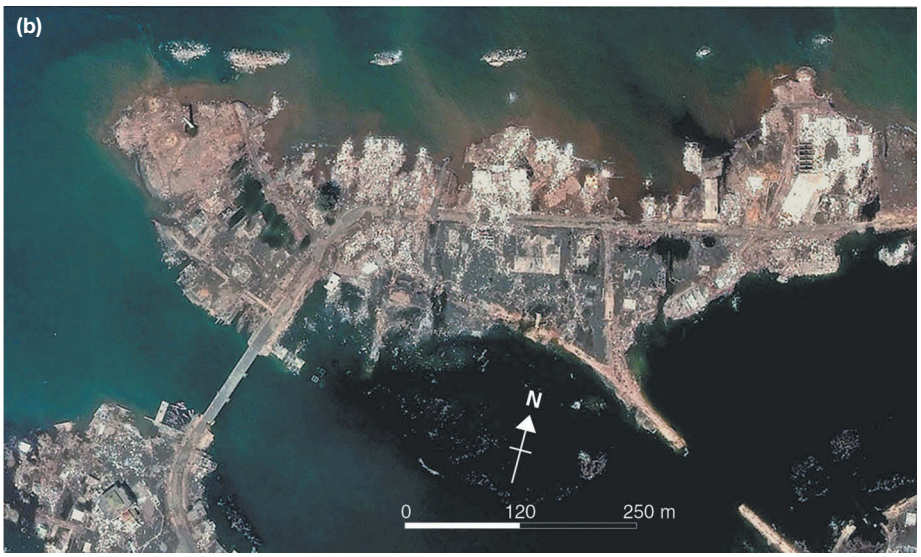
Interpretation of aerial photos provides a rich source of data for understanding the environment. We can obtain much information about a place by carefully analysing and interpreting an aerial photograph. We also need to be able to describe aerial photographs to others. Some groups that use aerial photos are:

- urban developers
- firefighters
- search and rescue organisations
- transport authorities
- agronomists (people who manage land and crops).

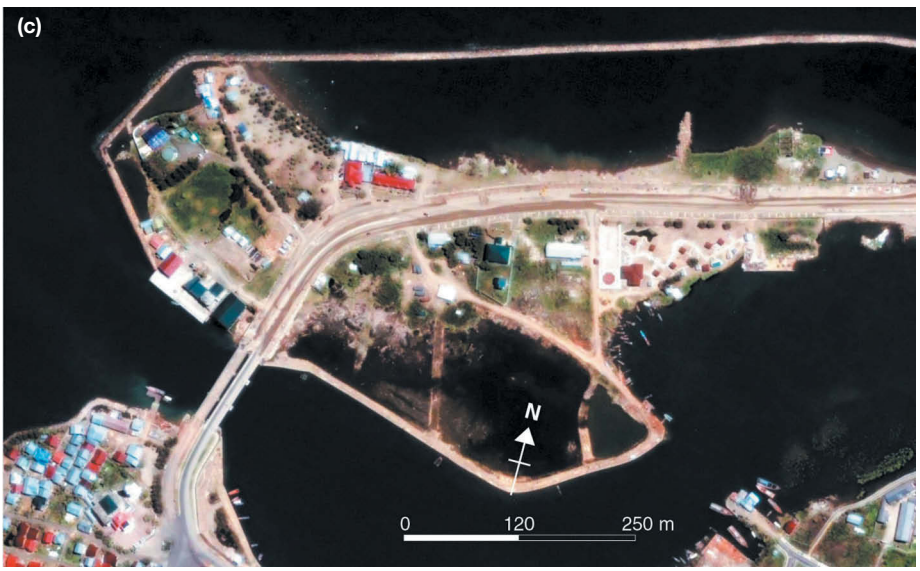
FIGURE 4 Satellite images of Banda Aceh, Indonesia, (a) before, (b) two days after and (c) four years after the tsunami on 26 December 2004



Source: © AFP/Newspix



Source: © AFP/Newspix



Source: Geoimage Pty Ltd © DigitalGlobe 2009

Model

The small Australian country town shown in figure 5 is predominantly of a rectangular shape with a grid road system. A major road becomes a divided road as it passes through the town centre. Beside this road is found the main shopping strip. The houses are on quite large blocks of land and most gardens have trees. Backyard swimming pools are scarce. The local bowling club can be found in the south-east of town. There appears to be some expansion of the town toward the west. This aerial photograph was taken either in summer when the land is dry or the town is in a low rainfall environment.

FIGURE 5 Vertical aerial photograph



Interpreting aerial photographs involves:

- identifying key features by recognising elements such as shapes, colours, patterns and textures
- describing the main aspects in detail.

eBook*plus*

eLesson
Interpreting an aerial photo
Searchlight ID: eles-1654

5.9.2 Show me

How to interpret a vertical aerial photo

You will need:

- a vertical aerial photo.

Procedure:

To identify features on an aerial image, such as that in figure 5, you need to apply the elements of interpreting an aerial photo — shapes, size, tone, patterns and texture.

STEP 1

Firstly, let's consider 'shape' and 'size'. Objects from a vertical viewpoint have obvious shapes. Buildings appear as blocks (you are looking at the roof only). Small blocks are houses; larger blocks are factories if a number are grouped together; single, larger blocks are generally public buildings such as schools, halls and shopping centres. Oval or round shapes are sporting grounds/tracks. Can you imagine a golf course from above? Its size is large; its shape indicates green grass and rows of trees dividing the fairways. Look around the aerial photo in figure 5 and identify the trees in the median strip of the major road.

STEP 2

'Texture' and 'tone' are gained from the objects themselves in the course of the photography. Texture indicates whether the object has a degree of smoothness or whether it is rough. A mown oval will appear as a 'smooth green'; a forest will appear as 'lumpy and various greens' according to the size and species of trees in the forest; farmland sown to different crops and with some land ploughed will appear as a mosaic of colours.

Tone is the reflection of light from objects to the camera.

- Water glistens when clear, but appears brown when in flood.
- The deeper the water, the darker the colour.
- Sealed highways reflect light in comparison to the dirt of rural tracks.
- Sandy beaches glow a cream colour compared to the dark colour of bare soil.

Figure 5 shows a range of different sized and surfaced roads.

STEP 3

'Pattern' is what a geographer delights in observing, as they try to understand the world around them. This involves discovering key patterns in the aerial photograph. Towns generally have a series of roads on a grid pattern. Rivers, as a natural feature, wind their way through an environment. Irrigation channels and railway lines built by man appear as straight lines. Figure 5 shows how readily the boundary can be identified in this rural environment.

5.9.3 Let me do it

Developing my skills

Use the vertical aerial image of Villarrica volcano, Chile (figure 6). Use the steps to identify key shapes, sizes, patterns and textures. Expand the size of this aerial photo and, using the Paint program (or similar software), label the following features:

- the central vent
- snow covered area
- mud and/or lava flows
- lakes
- barren land
- forested areas
- a coastal settlement.

Check your work with your teacher.

FIGURE 6 Villarrica volcano, Chile



Source: © NASA Earth Observatory image by Jesse Allen and Robert Simmon, using EO-1 ALI data provided courtesy of the NASA EO-1 team.

Questions

1. Why do you think the mountain peak is covered in snow?
2. What is the source of the water in the lakes?
3. Suggest why some of the land is bare in the aerial photo.
4. How do you know that small areas of land near the base of the volcano are used for agriculture?
5. By its shape, what type of volcano is Mount Villarrica?

eBook*plus*

Interactivity
Interpreting an aerial photo
Searchlight ID: int-3150

Checklist

I have:

- interpreted shapes, sizes, tones, patterns and textures on a vertical aerial photograph
- written a detailed description of the vertical aerial photograph.

Skills questions

1. Vertical aerial photos see the landscape:
   a. from ground level
   b. at an angle
   c. from over the hill
   d. from directly above.
2. Aerial photos show details such as:
   a. soil fertility
   b. landforms
   c. rainfall levels
   d. number of people in a house.
3. Why do buildings such as houses usually appear as squares in aerial photos?
4. How is it possible to identify different types of forests, different types of crops growing and different depths of water in aerial photos?

5.10 How are volcanic mountains formed?

5.10.1 How are volcanoes formed?

A volcano is a cone-shaped hill or mountain formed when molten magma in the Earth's mantle is forced through an opening or vent in the lithosphere. Almost all active volcanoes occur at or near plate boundaries. Some occur where two plates converge, and others occur where the plates are pulling apart, or diverging (see figure 1). There is another group of volcanoes that are formed when plates move over hotspots.

Subduction zones

Some volcanoes are formed when an oceanic plate is pulled underneath a continental plate (see subtopic 5.4). As the crust is forced down, it heats up and becomes magma. It can then rise to the Earth's surface through a magma chamber.

Volcanoes in rift zones

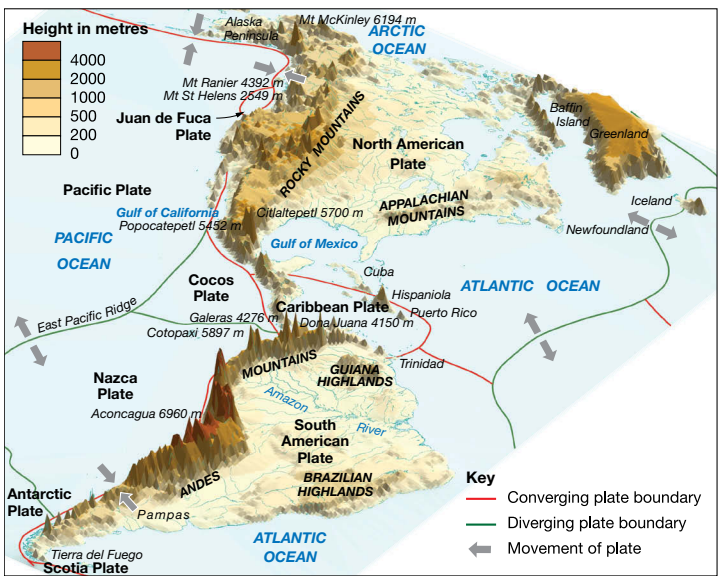
The longest mountain range in the world is underwater between the African and American continents, and is 56 000 kilometres long. It is called the Mid-Atlantic Ridge, and it is made up of many volcanic mountains. The volcanoes are formed where two plates move away from each other in **rift zones**. The molten lava rises to the surface in the space between the plates, and the largest volcanoes appear above the water as islands. Examples of rift islands are Iceland, the Azores, Ascension Island, Gough Island and Bouvet Island. The rifting, or spreading apart, can occur on land or on the seabed.

rift zones a large area of the Earth in which plates of the Earth's crust are moving away from each other, forming an extensive system of fractures and faults

The rifting of Iceland

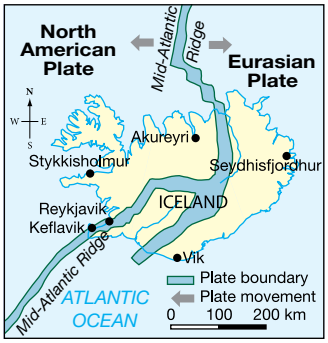
The Mid-Atlantic Ridge passes through Iceland, where the island is splitting in two different areas (see figure 2). This can be seen where Iceland's volcanoes are located, at the point where the North American Plate is drifting to the west and the Eurasian Plate is drifting to the east (see figure 3). New crust is being formed in a rift below the sea, and eventually water from the Atlantic Ocean will fill the widening and deepening gaps between the separated parcels of land.

FIGURE 1 Landforms of North, Central and South America (not to scale)



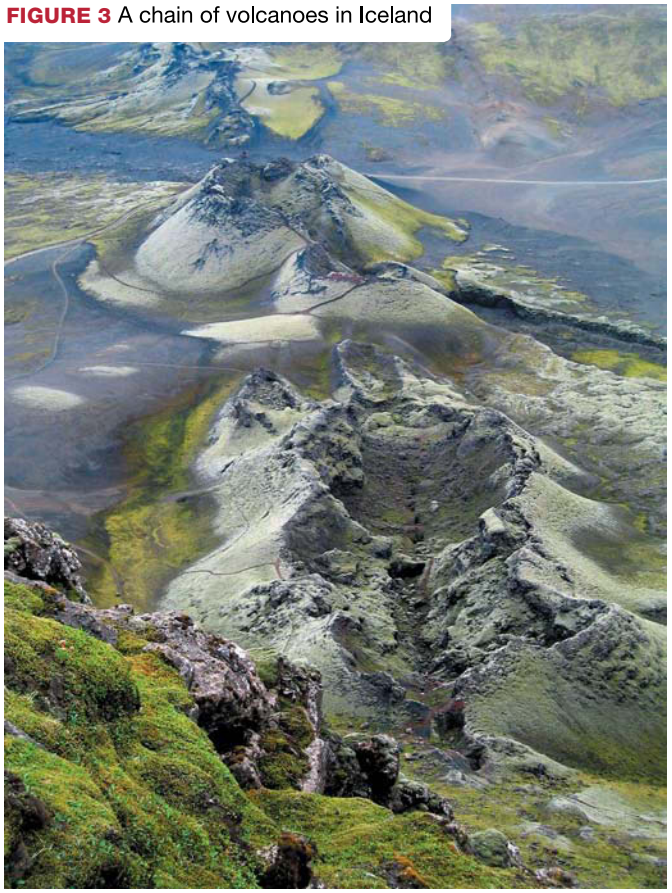
Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 2 Rifting in Iceland



Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 3 A chain of volcanoes in Iceland



The Great Rift Valley, Africa

The Great Rift Valley is in Africa (figure 4). It is about 5000 kilometres long, and stretches from Syria in the north to Mozambique in the south. The valley varies in width from 30 kilometres at its narrowest point to 100 kilometres at its widest. In some places it is a few hundred metres deep; in others it can be a few thousand metres deep.

The Great Rift Valley was created through separation that began 35 million years ago, when the African and Arabian plates began pulling apart in the northern region. About 15 million years ago, East Africa began to separate from the rest of Africa along the East African Rift. The volcanic activity in this region has produced many volcanic mountains, such as Mount Kilimanjaro, Mount Kenya and Mount Elgon.

As these rifts continue to grow, new ocean waters will flow into the valleys, separating the landmasses.

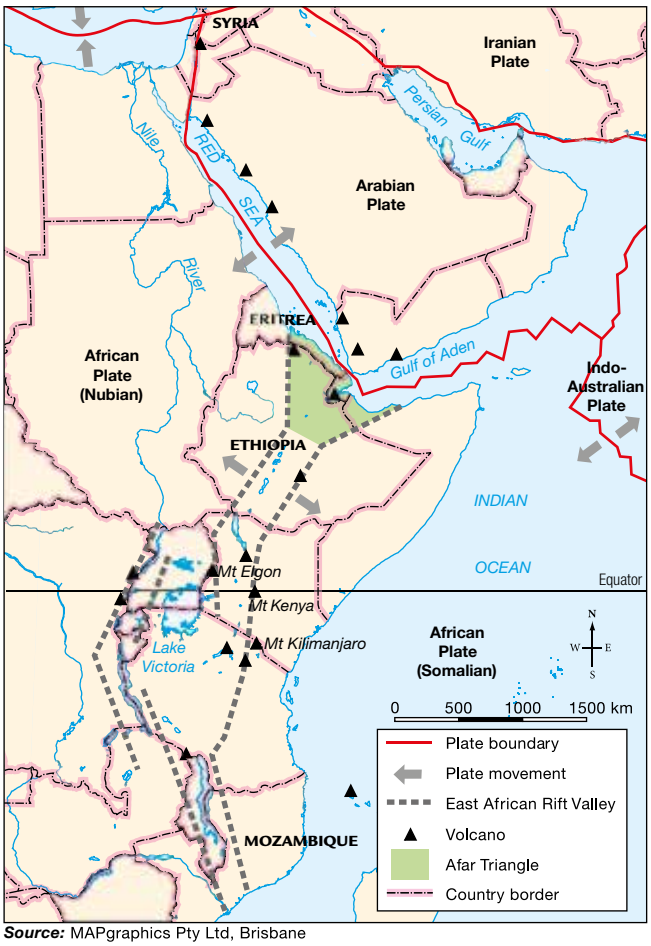
5.10.2 Volcano hotspots

hotspot an area on the Earth's surface where the crust is quite thin, and volcanic activity can sometimes occur, even though it is not at a plate margin

Although most volcanoes are formed on plate boundaries, some are located in the middle of plates, a long way from plate boundaries. These volcanoes have formed above a **hotspot** — a single plume of rising mantle. Volcanoes form as the plates slowly move over the hotspot and, over time, a chain of volcanoes can form. Hotspots are found in the ocean and on continents. Examples include the Hawaiian Islands and many of Australia's extinct volcanoes. In Hawaii, the location of the volcanoes gives a clue to the direction and speed of the plate movement.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Hawaii's hot spot

FIGURE 4 The Great Rift Valley, Africa



Source: MAPgraphics Pty Ltd, Brisbane

eBook*plus*

Weblink
Hawaii's hotspot

ACTIVITIES

EXPLAIN

1 Go to the **Hawaii's hotspot** weblink in the Resources tab and explain how hotspot volcanoes form.

2 Refer to figures 2 and 3. Explain why a chain of volcanoes, like the one in the photograph, forms in Iceland. What is happening to the plates?

INVESTIGATE

3 Use an atlas to find the Cotopaxi volcano. In which country is it located? How high is it?

4 Use an atlas or Google Earth to locate the islands on the Mid-Atlantic Ridge. Give the latitude and longitude for three locations. Describe the ***interconnection*** between the location of the ridge and the location of islands and volcanoes.

PREDICT

5 Draw what you imagine Iceland will look like many thousands of years in the future after further rifting. Provide new names for each of the smaller islands. In which direction, and towards which continent, will each island drift? Describe key ***changes***.

6 Draw a series of sketches to show what you predict will happen to the African landmass as the Great Rift Valley continues to rift. Include a map of Africa showing the ***change*** in shape that might occur. You need to annotate your sketches to justify the predictions you have made.

APPLY

7 Refer to an atlas map of Africa and look at the shape of the island of Madagascar. Try to imagine fitting this island back into the mainland. Using plate tectonic terms, write a paragraph to describe how Madagascar's location has ***changed*** over time.

8 Describe the ***changes*** that are occurring in
- **a** the Great Rift Valley
- **b** Iceland

that are causing volcanoes to form.

9 How is the ***scale*** of the ***changes*** happening in Iceland different from the ***scale*** of ***change*** happening in the Great Rift Valley?

5.14 Review

5.14.1 Review

Mountains and plate tectonics

1. Write your own definition and explanation of continental drift and plate tectonics. Use your own sketched and labelled diagrams to help with your explanation.
2. What is the relationship between the location of mountains and mountain ranges and plate tectonics? Choose three examples from different ***places*** for your explanation.
3. How did the Himalayas form?
4. Describe the general location and distribution of the world's earthquakes and volcanoes. What is the relationship between this distribution and the location of plate boundaries?
5. Explain the terms *subduction*, *convergent plate*, *divergent plate* and *focus*. How is each involved in mountain building?
6. How can a hotspot create a chain of islands? What other tectonic activity can result in a chain of islands?

People and earthquakes

7. The following earthquakes are not the largest that have ever occurred, but they have resulted in enormous loss of life and damage.

TABLE 1 Eight earthquakes that have been especially destructive

Place	Date	Magnitude	Number of deaths	Cost (US$)
Ercis, Turkey	October 2011	7.2	More than 600	Not known
Christchurch, New Zealand	February 2011	6.3	181	$20 billion
Pakistan, India, Afghanistan	October 2005	7.6	80300	More than $5 billion
Sichuan, China	May 2008	7.9	84000	$85 billion
Bam, Iran	December 2003	6.6	30000	About $1 billion
Izmit, Turkey	August 1999	7.4	30000	$6.5–10 billion
Papua New Guinea	July 1998	7, followed by tsunami	More than 2000	Whole villages, lagoon destroyed
Port-au-Prince, Haiti	January 2010	7.3	230000	$8.5 billion

   a. Do you think that earthquakes and tsunamis should be measured by their size on the Richter ***scale***, by the number of people killed, or by the cost of the damage caused?
   b. Locate these earthquakes on a world map that shows plate boundaries (for example, figure 1 in subtopic 5.4). What is the relationship between these earthquakes and the plate boundaries?
   c. Compare the size of these earthquakes with the largest ones described in table 2 in subtopic 5.7. What are all the factors that contribute to large loss of life and to the amount of damage in an earthquake?
8. 'If people are well prepared for earthquakes and volcanic eruptions, there will be fewer deaths and injuries and less destruction and damage.' What is your opinion about this statement? Justify by using some examples.
9. Explain how mountain landscapes determine how land is used and managed. Refer to the 'Mountain landscapes' Extended Writing Task in your Resources section to guide your response to this question.

5.14.2 Reflect

Heard Island — Australia's active volcano

The Heard and McDonald Islands are a group of sub-Antarctic islands in the south-west Indian Ocean. They are 1000 kilometres north of Antarctica.

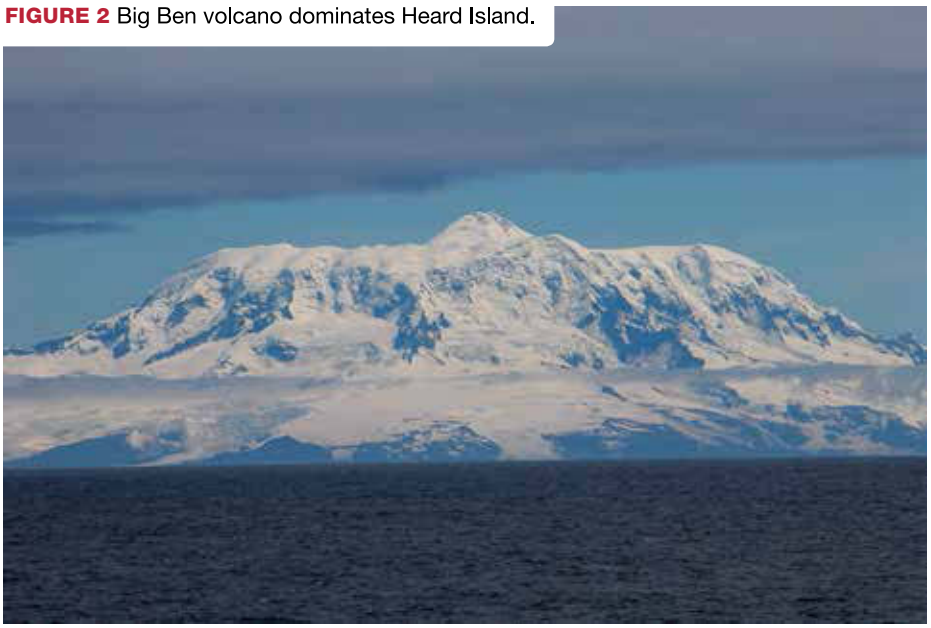
Heard Island is dominated by Australia's only active volcano, Big Ben, which is 2745 metres above sea level. Active plumes have been observed on Big Ben since 1947, and lava activity has been recorded on satellite images. Heard Island is colonised by both animals — albatrosses, petrels, gulls, penguins and seals — and plants — mosses, lichens and some vascular plants (those with a system of vessels to transport water and nutrients from roots to leaves).

FIGURE 1 Location of Heard and McDonald Islands



Source: Map courtesy of the Australian Antarctic Division
© Commonwealth Australia 2012

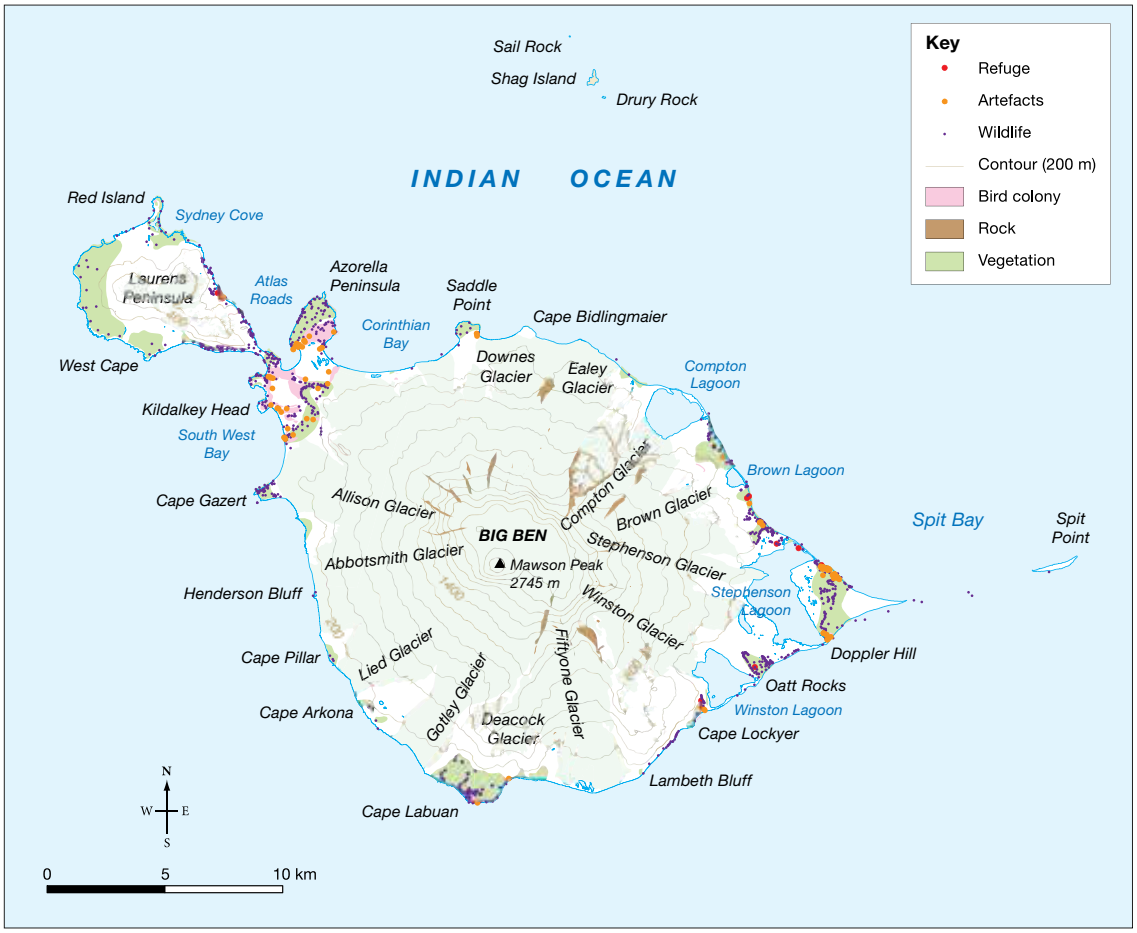
FIGURE 2 Big Ben volcano dominates Heard Island.



Refer to figures 1–3

10. How far away, and in which direction, are Heard and McDonald Islands from Perth?
11. What evidence is there that these islands are volcanically active?
12. What is the highest point on Heard Island?
13. Draw a cross-section of Heard Island from Compton Lagoon to Cape Pillar. Describe the shape of the island. How does this reflect the landform?

FIGURE 3 Topographic map of Heard Island



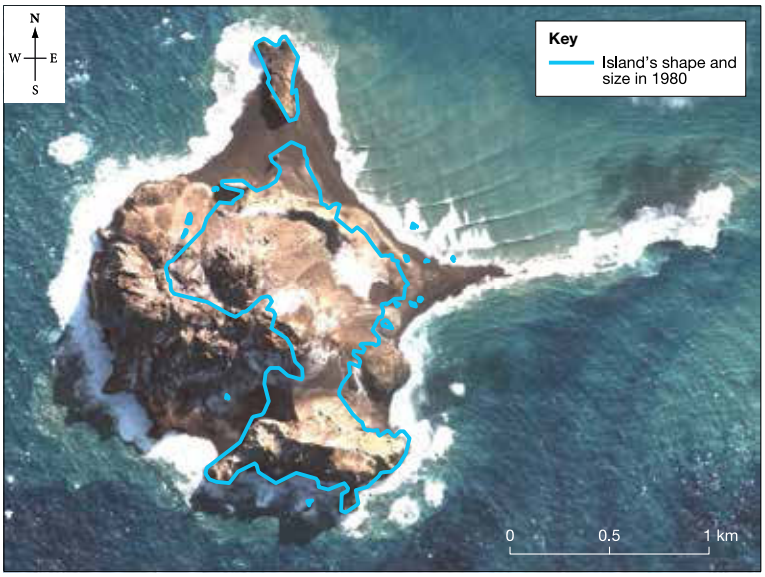
Source: Data courtesy of the Australian Antarctic Division © Commonwealth Australia 2012

McDonald Island — a volcanic hotspot?

McDonald Island is about 40 kilometres to the west of Heard Island. Recent satellite images have shown that a hotspot under the island was responsible for volcanic activity in the early 1990s, which increased the size and height of McDonald Island — it is now twice the size it was in 1980 and almost 100 metres higher. It is thought that the island had been dormant for 75 000 years before this eruption. Also, McDonald Island and Flat Island, which were once separate, are now joined.

14. Why is there volcanic activity on McDonald Island?
15. Briefly explain why McDonald Island is increasing in size.
16. Use the ***scale*** on the satellite photo (figure 4) to measure the island from its widest and longest points. How has this ***changed*** since 1980?
17. Heard Island is 40 kilometres from McDonald Island. How might plants and animals come to colonise this growing island?

FIGURE 4 McDonald Island has grown over time. The blue line shows the island's shape and size in 1980.



Source: Satellite image © DigitalGlobe 2003, map courtesy of the Australian Antarctic Division © Commonwealth Australia 2012



Aerial view of the Amazon rainforest in Peru, South America

CHAPTER 6

Rainforest landscapes

6.1 Overview

6.1.1 Introduction

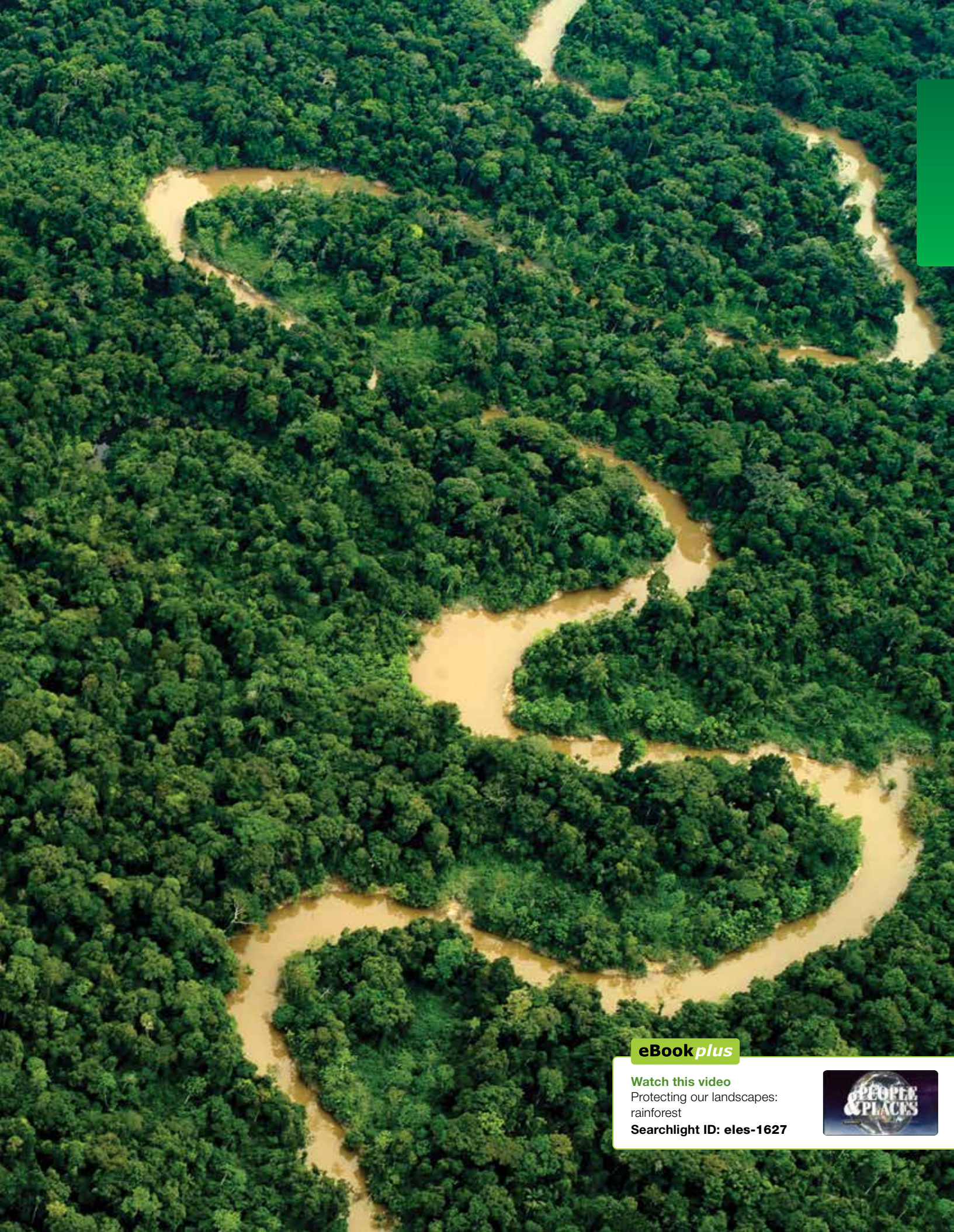
What do you know about rainforests? Did you know that rainforests have the greatest biodiversity of any forest environment? They contain complex layers that support thousands of species of plants and animals. The rainforest has supplied resources to all people, including indigenous communities. People are concerned that clearing large areas of rainforest is creating negative impacts that are unsustainable.

Starter questions

1. Create a mind map of all the words that come to your mind when you hear the word *rainforest*. Place these words into specific categories such as *animals*, *plants*, *colours* or *structure*.
2. Using magazines, newspapers, the internet and other resources, create a collage that represents a rainforest to you. What emotions does this image make you feel?
3. Refer to the image on these pages. Why do we call rainforests a 'green landscape'?
4. Try to list the things in your home that might originally have come from a rainforest. Have they ***changed*** from their original form? How do you think they got here?
5. Think of your favourite place, the place you most like visiting. How would you feel if that place was ***changed*** or destroyed and you could not visit or use it in ways you used to? What could you do about this?

Inquiry sequence

		Syllabus outcomes
6.1 Overview		
6.2 What are the characteristics of a rainforest?		GE4-1, GE4-7, GE4-8
6.3 SkillBuilder: Understanding thematic maps	eBook*plus* ONLINE ONLY	
6.4 What is a rainforest ecosystem like?		GE4-1, GE4-7, GE4-8
6.5 SkillBuilder: Creating and describing complex overlay maps	eBook*plus* ONLINE ONLY	
6.6 How have Australia's rainforests changed?		GE4-2, GE4-4, GE4-7, GE4-8
6.7 How is the Amazon rainforest changing?	eBook*plus* ONLINE ONLY	GE4-2, GE4-4, GE4-7, GE4-8
6.8 SkillBuilder: Drawing a précis map		
6.9 How do indigenous people use rainforests?		GE4-4, GE4-5, GE4-7, GE4-8
6.10 Why are rainforests disappearing?		GE4-4, GE4-5, GE4-7, GE4-8
6.11 How does deforestation affect the environment and people?		GE4-4, GE4-5, GE4-7, GE4-8
6.12 How can rainforests be conserved?		GE4-5, GE4-7, GE4-8
6.13 Investigating topographic maps: What are the features of the Daintree rainforest?		GE4-4, GE4-5
6.14 Review	eBook*plus* ONLINE ONLY	
Key terms	eBook*plus* ONLINE ONLY	



eBook*plus*

Watch this video
Protecting our landscapes: rainforest
Searchlight ID: eles-1627

6.2 What are the characteristics of a rainforest?

6.2.1 Introducing rainforests

Forests that grow in constantly wet conditions are called rainforests. A rainforest is an example of a biome (a community of plants and animals spread over a large natural area). Rainforests are located wherever the annual rainfall is more than 1300 millimetres and is evenly spread throughout the year. While tropical rainforests are the best known, there are also other types.

equatorial near the equator, the line of latitude around the Earth that creates the boundary between the northern and southern hemispheres

Rainfall

Rainforests thrive in the hot and wet conditions experienced in the **equatorial** regions of the world. Most of the time the rainfall is extremely heavy, caused by thunderstorms. These heavy downpours, called **convectional rainfall**, result in very hot and humid conditions.

convectional rainfall heavy rainfall as a result of thunderstorms, caused by rapid evaporation of water by the sun's rays

6.2.2 Types of rainforests

Tropical rainforests

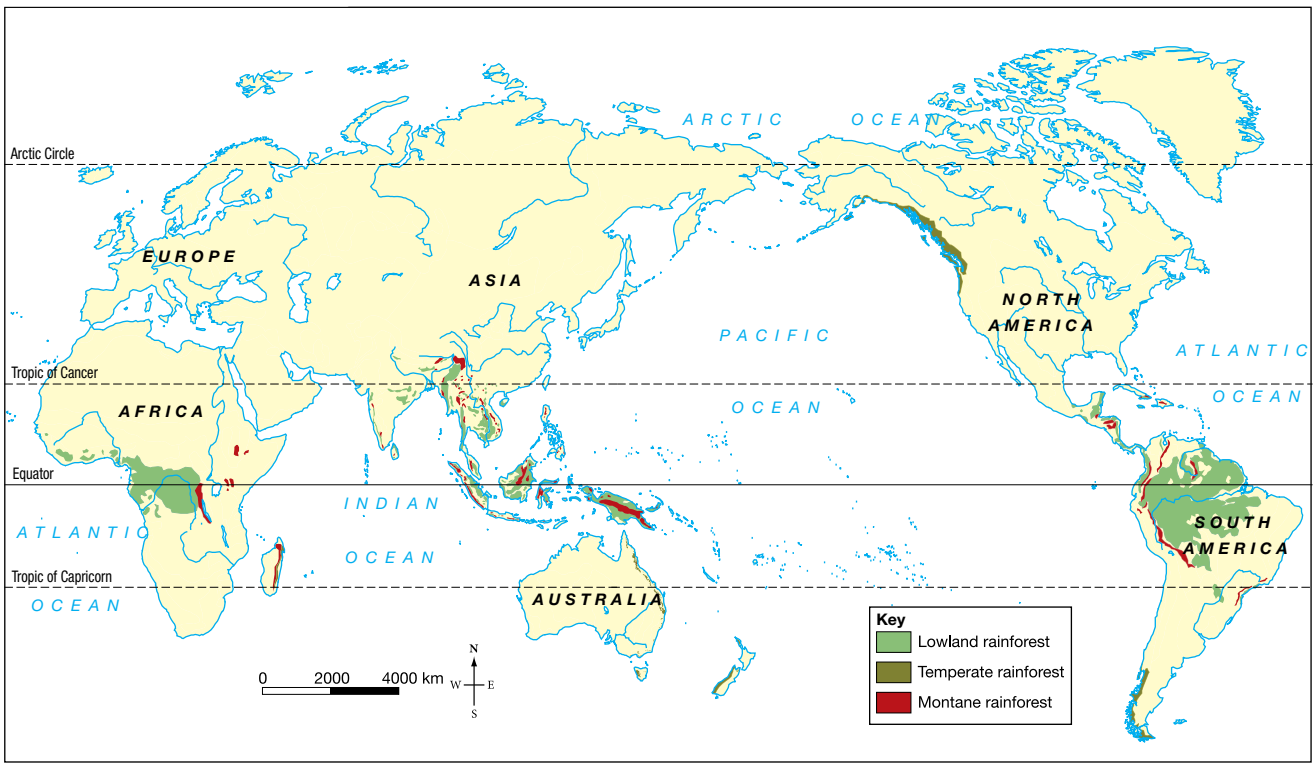
Tropical rainforests are located around the equator (see figure 1) where the temperatures are warm all year round and there is a lot of rainfall. Plants flourish in humid, moist tropical rainforests, which support a huge number of plants and animals — perhaps as many as 90 per cent of all known **species**. Poison-dart frogs, birds of paradise, piranha, tarantulas, anacondas, Komodo dragons and vampire bats are all found in tropical rainforests. Tropical rainforests can occur at different altitudes; they are called montane rainforests and lowland tropical forests.

species a biological group of individuals having the same common characteristics and able to breed with each other

Montane rainforests

Tropical rainforests that occur in the mountains, 1000 metres or more above sea level, are called montane rainforests. Montane rainforests have lower trees than lowland tropical forests and are almost always covered by clouds, making the leaves drip with moisture (see figure 2).

FIGURE 1 World rainforest types



Source: MAPgraphics Pty Ltd Brisbane

FIGURE 2 Montane rainforest



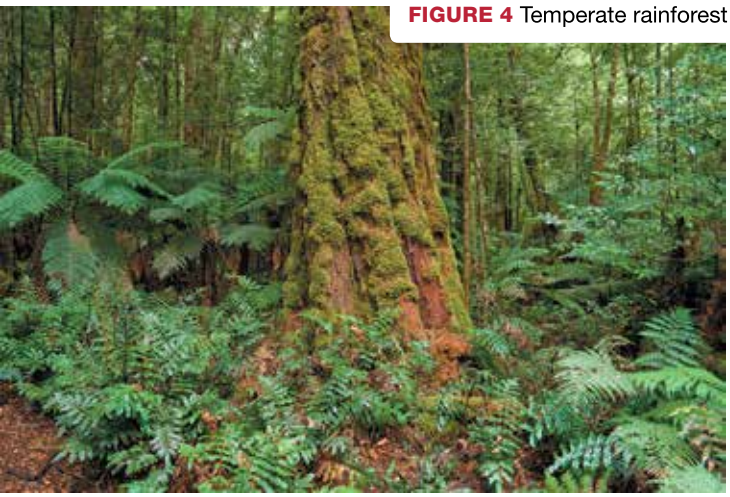
FIGURE 3 Lowland rainforest



Lowland tropical forest

Lowland tropical rainforests form the majority of the world's tropical rainforests (see figure 3). They grow at elevations generally below 1000 metres. Trees in lowland forests have a great diversity of fruiting trees, attracting animals and birds adapted to feed on their fruits. These rainforests are far more threatened than montane forests because of their accessibility, soils that are more suitable for agriculture and more valuable hardwoods for timber. Lowland forests occur in a belt around the equator, with the largest areas in the Amazon Basin of South America, the Congo Basin of central Africa, Indonesia and New Guinea.

FIGURE 4 Temperate rainforest



Temperate rainforests

The large area of the globe between the tropics and the polar regions (areas within the Arctic and Antarctic circles) is called the **temperate** zone, and rainforests can grow there too. Temperate rainforests occur in North America, Tasmania, New Zealand and China (see figure 4). Giant pandas, Tasmanian devils, brown bears, cougars and wolves all call temperate rainforests home.

temperate describes the relatively mild climate experienced in the zones between the tropics and the polar circles

6.2.3 Physical processes of a rainforest

Rainforests are the result of the interaction between the Earth's four main systems or spheres. For example, the trees in a tropical

rainforest (biosphere) rely on high levels of precipitation (hydrosphere), warm temperatures (atmosphere) and stability provided by soil (lithosphere) to thrive. Energy from the sun is stored by plants (biosphere). When humans or animals (biosphere) eat the plants, they acquire the energy originally captured by the plants.

GEOskills TOOLBOX

Thematic maps
A thematic map is a type of map that shows a particular theme; for example, the different climate types that occur across a geographic area. Several thematic maps can be used at once to determine interconnections that exist around the world.

ACTIVITIES

IDENTIFY
1 What conditions do rainforest ***environments*** thrive in?
2 What are the differences between montane and lowland rainforest ***environments***? What causes these ***changes*** in rainforest type?
3 Describe the distribution of rainforests around the world. Think about in which continents and between which latitudes they are found, the size and ***scale*** of them, and whether they are continuous or scattered.

EXPLAIN
4 Why are lowland rainforest ***environments*** more threatened by human activity than montane rainforests?
5 Why are montane forests often called 'cloud forests'?

INVESTIGATE
6 Refer to figure 1.
a Use an atlas to help you name six countries in the Asia–Pacific region that contain rainforests.
b What type of rainforest ***environment*** is found:
i in north-eastern Australia
ii along the western coastline of Canada?

APPLY
7 Why are rainforest ***environments*** able to support a large range of animals and plants?

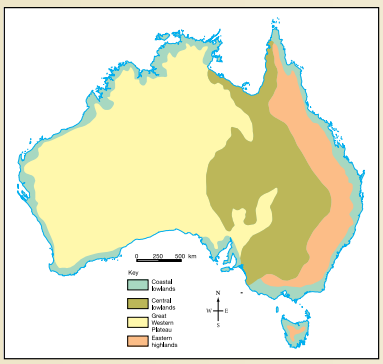
eBookplus

Interactivity
Our living green dinosaurs
Use this interactivity to learn more about Australia's rainforests.
Searchlight ID: int-3112

eBookplus ONLINE ONLY

6.3 SkillBuilder: Understanding thematic maps

What is a thematic map?
A thematic map is a map drawn to show one aspect; that is, one theme. For example, a map may show the location of vegetation types, hazards, or weather. Parts of the theme are given different colours or, if only one idea is conveyed, symbols may show location.



eLesson
Watch this video to learn how to understand thematic maps.
Searchlight ID: eles-1658

Interactivity
Try this interactivity to learn how to understand thematic maps.
Searchlight ID: int-3154

6.4 What is a rainforest ecosystem like?

6.4.1 Rainforest characteristics

Rainforests are unique **ecosystems** consisting of four different layers — the emergent, canopy and understorey layers and the forest floor. Each layer can be identified by its distinct characteristics. Rainforests are actually a community of plants and animals working together to survive, linked in a food web.

ecosystem an interconnected community of plants and animals in a particular environment

microclimate specific atmospheric conditions within a small area

compost a mixture of various types of decaying organic matter such as dung and dead leaves

Emergents

These are the tallest trees, ranging in height from 30 to 50 metres. They are so named because they rise up or emerge out of the forest canopy. Huge crowns of leaves and abundant animal life thrive on plenty of available sunlight.

Canopy

This describes the array of treetops that form a barrier between the sunlight and the underlying layers. Their height can vary from 20 to 45 metres. This layer contains a distinct **microclimate** and supports a variety of plants and animals. The taller trees host special vines called lianas that intertwine the branches. Other plants called epiphytes use the tree trunks and branches as anchors in order to capture water and sunlight.

Understorey

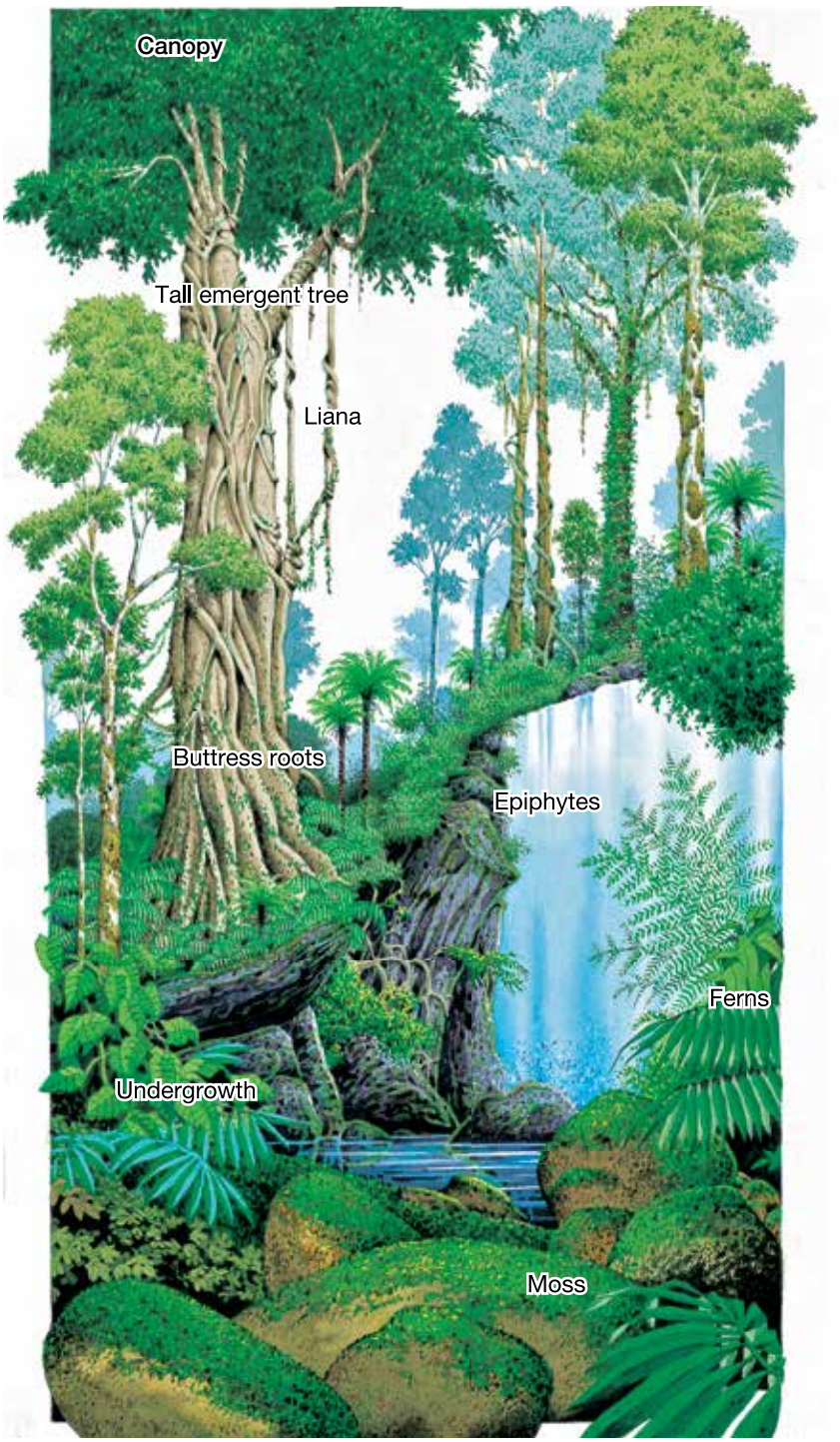
This layer contains a mixture of smaller trees, and ferns that receive only about five per cent of the sun's energy. Many animals move around in the darkness and humidity, using the vines as highways.

Forest floor

This bottom layer is dominated by a thick carpet of leaves, fallen trees and huge buttress roots that support the giant trees above. Rainforest soils give the impression of being fertile because they support an enormous number of trees and plants. However, this impression is wrong, as the soil in rainforests is generally poor. Leaves and other matter are recycled by the many organisms to create a living **compost**. The roots of trees must 'snatch' these nutrients from the soil before heavy rains wash them away and they are lost through a process called leaching.

Larger animals also roam through this layer in search of food.

FIGURE 1 Layers in a tropical rainforest



FOCUS ON FIELDWORK

Using Google Earth for virtual fieldwork

Google Earth is an excellent tool that can be used to visit lots of places all around the world. Use Google Earth to visit the Dorrigo National Park in New South Wales to view the layers of the rainforest.

FIGURE 2 Students using Google Earth to take a virtual field trip to Dorrigo National Park to learn about the vegetation



FIGURE 3 Dorrigo rainforest



ACTIVITIES

IDENTIFY

1 How many layers are there in a rainforest *environment*?
2 What are the tallest trees in the rainforest called?

EXPLAIN

3 Describe how conditions in the canopy layer differ from those on the forest floor.
4 Draw up and complete a table like the one below that summarises the features of a rainforest *environment*.

Layer	Height	Amount of light	Features

INVESTIGATE

5 Many rainforest animals live their whole life in the trees. Using the internet to help you, give some examples of these animals and conduct research into the habits of one animal.
6 Use the **Treehouse** weblink in your eBookPLUS (click on the picture, then select the *Jewels of the Earth* activity) to explore the layers of the rainforest and the plants and animals that inhabit them.

APPLY

7 In a rainforest, the soil below the trees is often poor and shallow, and the trees create their own nutrients. In one sentence describe how this happens, and draw a labelled sketch to illustrate the process.
8 What *change* might you expect in the success of plant growth if the rainforest trees are removed and crops are planted instead? Why?
9 Imagine you are a raindrop. Recreate your journey through a rainforest, passing through each of the forest layers. Read or act out your descriptions to the rest of the class.

eBookplus

Weblink
Treehouse

eBookplus ONLINE ONLY

6.5 SkillBuilder: Creating and describing complex overlay maps

What is a complex overlay map?

A complex overlay map is created when one or more maps of the same area are laid over one another to show similarities and differences between the mapped information. Traditionally, the second map is on tracing paper that is attached to the original page. Complex overlay maps show relationships between factors — the similarities and the differences in a pattern.

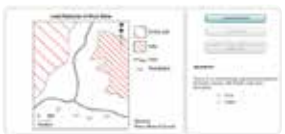


eLesson
Watch this video to learn how to create and describe complex overlay maps.



Searchlight ID: eles-1656

Interactivity
Try this interactivity to learn how to create and describe complex overlay maps.



Searchlight ID: int-3152

6.6 How have Australia's rainforests changed?

ice age a geological period during which the Earth is colder, glaciers and ice sheets expand and sea levels fall. The last ice age was approximately 13 000 years ago.

gorge narrow valley with steep rocky walls

6.6.1 Australian rainforests today

Although hard to believe now, Australia was once mostly covered in rainforest! Even areas that today are deserts were once teeming with plant and animal life similar to those in the Amazon. This is because Australia was further north than it is today. Over the past 100 million years, however, a series of events has gradually reduced the area of Australia's rainforests (see figure 1).

The gradual movement of Australia as it separated from Gondwanaland and a series of **ice ages** have combined to make it a drier place (see figure 2). Rainforests have become confined mainly to the mountains and **gorges** of the Great Dividing Range and Tasmania. These areas have higher rainfall and fewer fires.

FIGURE 1 The development of Australian rainforests through time



Triassic period (245–208 mya)
- Foundation of Australian rainforests was occurring as massive volcanic eruptions laid down thick layers of ash near freshwater lakes.

Early Cretaceous period (144–95 mya)
- Australia, as part of Gondwanaland, was very close to the South Pole and experienced the same conditions as present polar regions. However, the climate was temperate, supporting plant life, and the first flowering plants appeared.

Late Cretaceous period (95–66.4 mya)
- The climate was temperate and humid; species found in rainforests today began to develop. Dinosaurs were still present.

Present

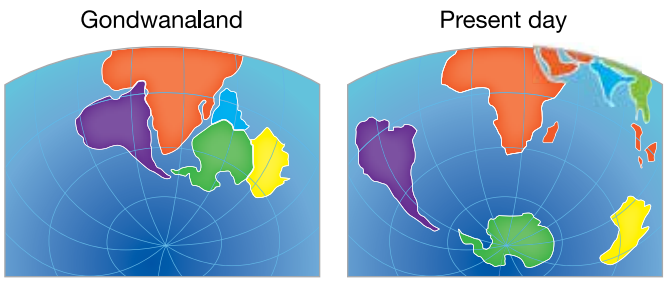
260 240 220 200 180 160 140 120 100 80 60 40 20

[Dates are expressed in mya — million years ago.]

Jurassic period (208–144 mya)
- Ash deposits developed into sedimentary rock; plants such as the cycad and southern pine first appeared.

Late Oligocene/early Miocene periods (25–20 mya)
- The whole of Australia was covered by rainforest at the start of this period, but by the end of the Miocene sclerophyll forest and grasslands were starting to emerge. The rainforests would have been similar to those of today.

FIGURE 2 Difference in the location of Australia when it formed part of Gondwanaland compared with its location today

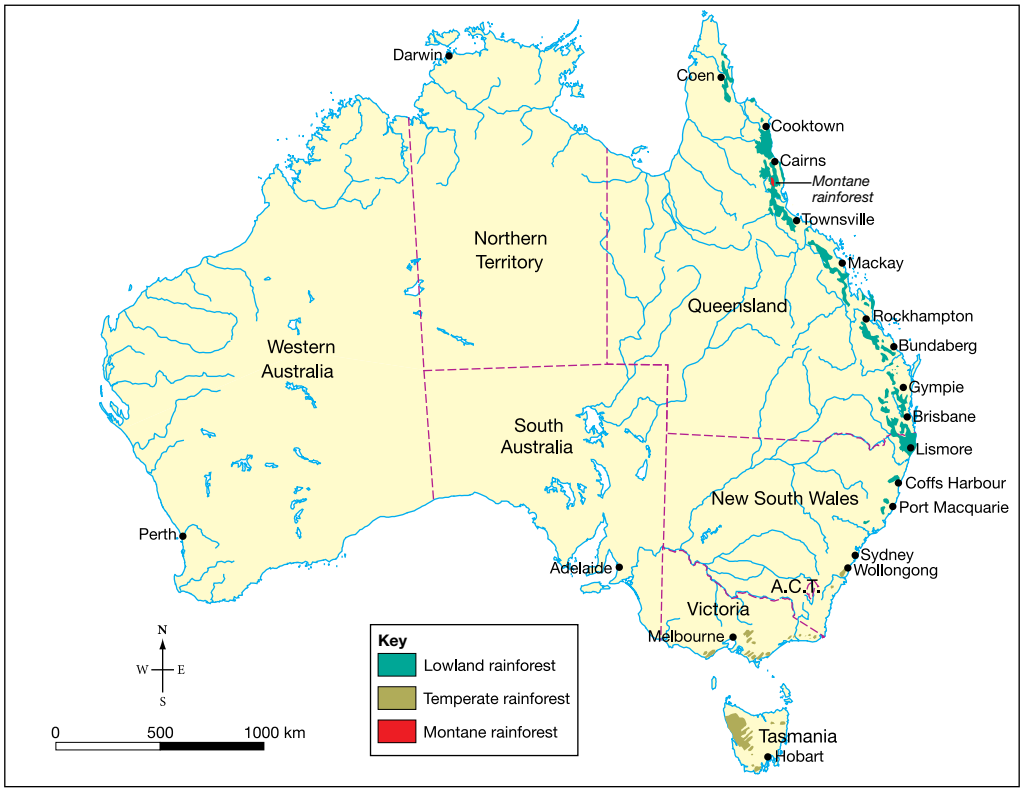


The farming practices of European immigrants have reduced much of the remaining rainforest — in the past 200 years, more than 70 per cent of these forests have been cleared.

Scientists have identified three major types of rainforest in Australia (see figure 3). There are examples of all three in Queensland. This diversity occurs nowhere else on Earth.

Much of Australia's tropical rainforests are now World Heritage areas. This means they have been listed by UNESCO as being of global importance. The Wet Tropics of Queensland are a World Heritage area containing some of the oldest rainforests in the world. They have the world's highest concentration of flowering plants, and have records that show Aboriginal groups are the world's oldest indigenous rainforest culture.

FIGURE 3 Australia's rainforest areas



Source: MAPgraphics Pty Ltd Brisbane

The indigenous inhabitants of the Daintree Rainforest in North Queensland are the Kuku Yalanji Aboriginal people, believed to have lived in this area for more than 9000 years. Their culture is uniquely adapted to the rainforest environment.

For the Kuku Yalanji, the natural world is often thought of in human terms and is closely linked to the people. Any changes to the environment are seen as changes to themselves. Because of the powerful properties attributed to most story places (sites with links to Dreamtime mythology) of the Daintree, the Kuku Yalanji regard damage and destruction to the environment as unacceptable.

The Kuku Yalanji people gather their food and medicine and many of their implements, weapons, fibres and construction material from plants in their environment (see figure 4). The natural patterns and cycles of the rainforest give important information about the food that is available. The plants are their calendar, marking the seasons. For example, when blue ginger (jun jun) is fruiting it is time to catch scrub turkey (diwan), and when mat grass (jilngan) is flowering it is time to collect the eggs of the scrub fowl (jarruka).

FIGURE 4 Rainforest plants were used to make goods such as these baskets that were used for storage, food collection, carrying personal possessions, and leaching poisons (from seeds) in fresh running water.



ACTIVITIES

IDENTIFY

1 List the reasons given in this section for the gradual disappearance of Australia's rainforest ***environments***.

2 What resources does the rainforest provide for the Kuku Yalanji people?

EXPLAIN

3 How has the ***scale*** of Australian rainforest ***environments changed*** over time?

4 Describe the location and distribution of Australia's remaining rainforest ***environments***. What factors have contributed to their survival here?

5 There are three major types of rainforest ***environments*** found in Australia. What makes Queensland's rainforests unique? Why is this possible?

6 Refer to figure 3. Why are there no rainforest ***environments*** on the western side of Australia?

7 Why do the Kuku Yalanji people regard damage to the Daintree rainforest as unacceptable?

INVESTIGATE

8 Use the **UNESCO Heritage** weblink in your eBookPLUS to complete the following.
- **a** On a map of Australia, locate and label Australia's World Heritage sites.
- **b** Which three sites have been added most recently?
- **c** Which two sites protect Australian rainforests?
- **d** The Wet Tropics of Queensland are particularly special because they border another World Heritage site. What is this other site?
- **e** What criteria does UNESCO use to determine whether a natural region should be placed on its list?

APPLY

9 Based on the history of Australia's rainforests and the protection now in place for the remaining forests, what do you think the future holds for this important resource?

eBookplus

Weblink
UNESCO Heritage

eBookplus ONLINE ONLY

6.7 How is the Amazon rainforest changing?

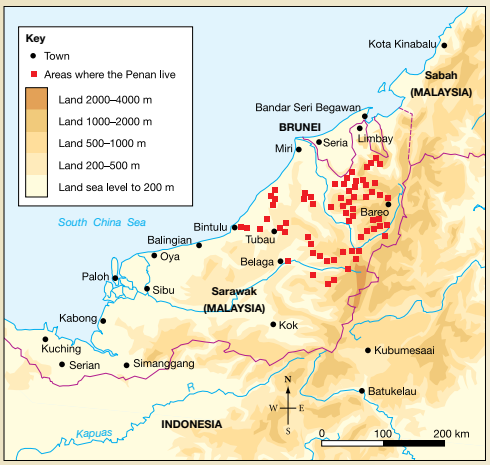
To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

6.8 SkillBuilder: Drawing a précis map

What is a précis map?

A précis map is a simplified map — the cartographer has decided which details to leave in and which to leave out. It is different from a sketch map, which includes all the main features.



Source: MAPgraphics Pty Ltd Brisbane

eLesson
Watch this video to learn how to draw a précis map.



Searchlight ID: eles-1657

Interactivity
Try this interactivity to learn how to draw a précis map.



Searchlight ID: int-3153

6.9 How do indigenous people use rainforests?

6.9.1 Indigenous rainforest peoples

It is difficult to accurately count all the people around the world who live in rainforests, but some estimates put the number as high as 150 million, including Indigenous people. While these people are usually described as living a traditional **subsistence** way of life, this is usually combined with selling and buying items such as their labour, their land and assorted forest products.

subsistence producing only enough crops and raising only enough animals to feed yourself and your family or community

The Huli of Papua New Guinea

Some 80 000 Huli people live in montane rainforest in the highlands of Papua New Guinea (see figure 1). Many still lead a traditional way of life. The land on which they live has steep hillsides and dense rainforest. In the mountains the rivers cut deep gorges, and as they reach flat areas they form swampy, fertile basins.

The Huli people today use a farming system known as **shifting agriculture**. A patch of rainforest is cleared and crops of sweet potato, sugar cane, corn, taro and green vegetables are planted. It is the role of the women to tend these gardens, and their individual huts are built next to the gardens. The men live together in a communal house and generally look after themselves.

When the soil of the garden no longer produces good crops, a new patch of rainforest is cleared, leaving the old one to recover naturally. The garden crops are supplemented by food that the men obtain by hunting. Wild and domesticated pigs are a common source of meat.

While most Huli people still live in their traditional lands, the influence of modern society is very obvious. Most Huli people wear some items of western-style clothing, and knives, cooking utensils and mirrors are common.

FIGURE 1 Location of Huli people in Papua New Guinea



Source: MAPgraphics Pty Ltd Brisbane

FIGURE 2 The Huli people of Papua New Guinea make wigs from their own hair, decorated with feathers from birds of paradise and colourful parrots.



The Penan of Borneo

The Penan people of Malaysian Borneo (see figure 3) are a truly **nomadic** rainforest people. Although their forest home has been largely destroyed by logging, about a thousand Penan people remain deep in the forest, following their traditional way of life.

The main food sources for the Penan people are the sago palm and other fruiting trees, but they are also extremely skilled hunters. They use blowpipes and poison darts to kill wild pigs and gibbons (see figure 4). Their knowledge of the rainforest has been built up over thousands of years, and the forest provides for all their needs. They do not use agriculture; instead, they follow the flowering cycle of the sago palm.

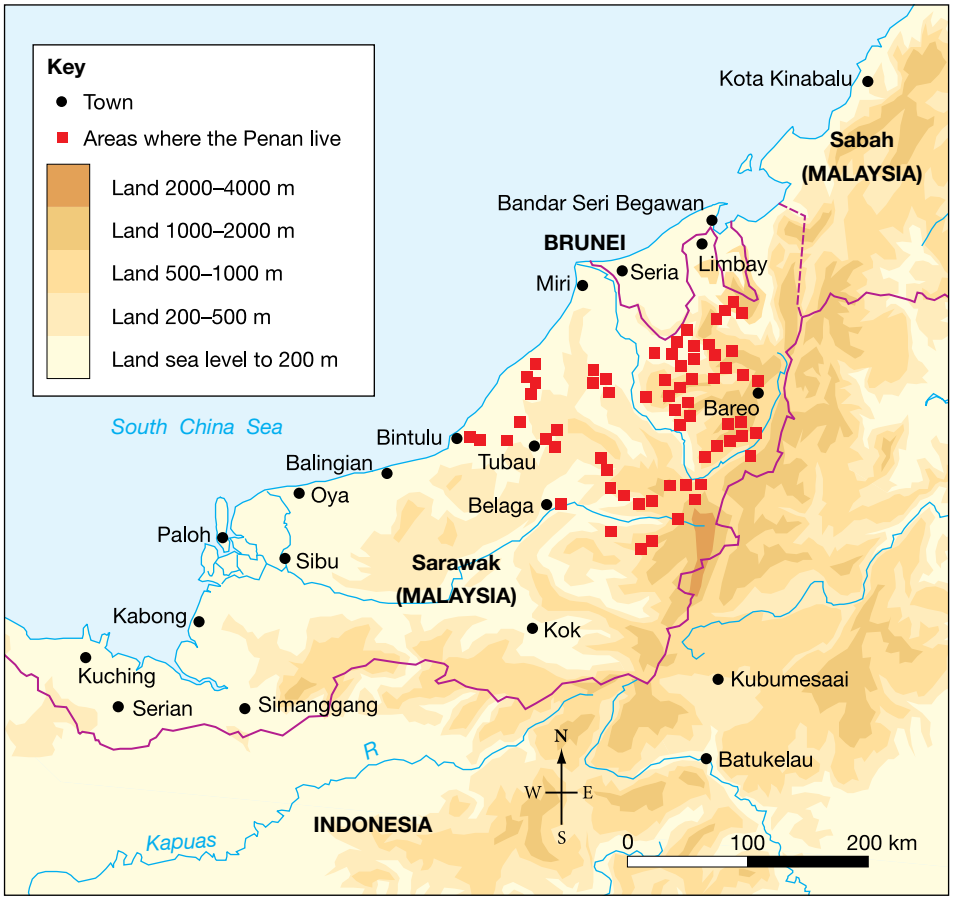
In order to survive in this environment, the Penan people have a strong culture of sharing. This applies not only to objects used in daily life, such as cooking utensils and blowpipes, but also to land. The idea of owning land does not exist in Penan culture.

The Penan people recently became well known to the outside world when they blockaded roads in the Malaysian rainforest to stop logging trucks and machinery moving into it.

shifting agriculture process of moving gardens or crops every couple of years because the soils are too poor to support repeated sowing

nomadic describes a group or tribes that move from place to place depending on the food supply

FIGURE 3 Where the Penan live



Source: MAPgraphics Pty Ltd Brisbane

FIGURE 4 A Penan hunter of Sarawak or Brunei can shoot a dart 50 metres from his blowpipe. About 1.2 metres long and completely straight, a blowpipe has a very accurate hole through the middle.



FIGURE 5 The houses of the Korowai and Kombai people can be constructed as much as 40 metres high in the forest's canopy.



The Korowai and Kombai of Papua

The Korowai and Kombai people live in the Indonesian province Papua, in the south-western part of the island of New Guinea. Mosquitoes, floodwaters and tribal rivalry have forced these tribes to build houses high up in the forest's canopy. They collect food (for example, sago) from the rainforest using traditional methods such as stone axes.

ACTIVITIES

IDENTIFY

1 Make a list of the similarities between the Huli people and the Penan people. Make another list of the differences between them. Use the photographs as well as the text in this section to help you.

EXPLAIN

2 The Penan use only rainforest resources to make their blowpipes. How do you think they do this? Use diagrams to illustrate your ideas.

3 Why is a blowpipe better than a rifle in the rainforest?

INVESTIGATE

4 Complete one of the following activities.

a In groups of two or three, use the internet to research other indigenous tribes living in rainforests around the world. Create a visual presentation or 'documentary' (using a program such as PowerPoint or Photo Story) to educate your classmates about the history of the tribe, their use of their ***environment***, and threats or ***changes*** they face. Examples of peoples you may like to investigate include the Kuna of Panama, the Yanomami of Brazil, the Mbuti of Central Africa and the Baka of Cameroon.

b In groups of two or three, use the internet to research indigenous tribes that live in or have a connection to the rainforest in Australia. Create a visual presentation or 'documentary' (using a program such as PowerPoint or Photo Story) to educate your classmates about the history of the tribe, their use of their ***environment***, threats or ***changes*** they face and their current relationship with the land.

5 Use the **Treehouse** weblink in your eBookPLUS (click on the picture then choose the *My world* activity) to let the community of Paso Caballos in northern Guatemala teach you about their lives in the rainforest.

PREDICT

6 Imagine that you live in a society in which no-one recognises individual ownership of anything. In groups of three or four, discuss the advantages and disadvantages of living in this type of society.

eBookplus

Weblink
Treehouse

6.10 Why are rainforests disappearing?

6.10.1 Reasons rainforests are disappearing

Rainforests have the potential to provide a wide variety of useful resources. The temptation to use these pristine areas is often too difficult for people to resist, especially if they live in poverty. As a result, all around the world, rainforests are being destroyed for economic gain. The main reasons for rainforests being cleared are shown in figure 1 and described below.

clearfelling a forestry practice in which most or all trees and forested areas are cut down

selective logging a forestry practice in which only selected trees are cut down

Commercial logging

There are two main types of logging: **clearfelling** and **selective logging**. When a forest is clearfelled, all trees are removed either by chainsaw or with heavy machinery such as bulldozers. In selective logging, only the best and most valuable trees are cut down. But in clearing forest to reach those trees, it is estimated that a hectare (10 000 square metres) of forest is destroyed for each log removed.

Farming

Rainforests grow in many developing countries. These countries struggle to provide the basic necessities of life for their people, and their populations are often rapidly increasing in size. In these countries, the land on which the forest grows is seen as more valuable than the forest itself.

FIGURE 1 Causes of deforestation in the Amazon, 2000–2005

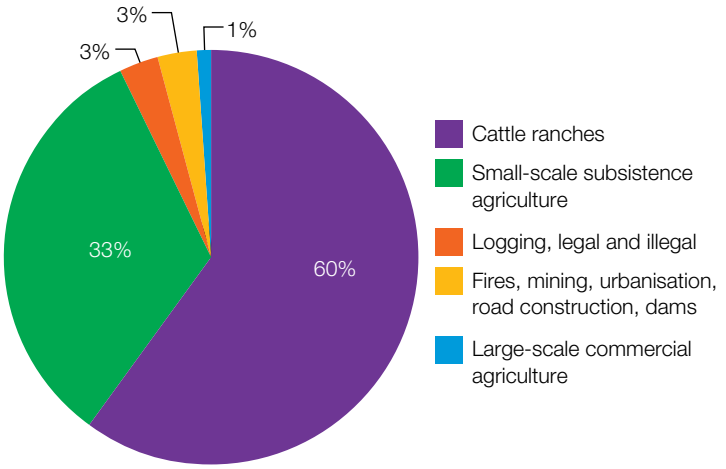


FIGURE 2 It is thought that up to 70 per cent of logging in Brazil and Indonesia could be illegal.



hydroelectric dam a dam that harnesses the energy of falling or flowing water to generate electricity

FIGURE 3 Blocks of rainforest in Peru burned to clear the area for agricultural use — here, maize seedlings have been planted in the clearing.



FIGURE 4 The Ok Tedi gold and copper mine in the Papua New Guinea rainforest. The damage that mining has caused to the surrounding forest environment can be clearly seen.



Highways create access to these areas, opening up parts of the rainforest once almost impossible to reach. Soon after the roads are built, settlers (called homesteaders) arrive. Claiming a piece of the forest that borders the road, the homesteaders chop down a few trees as timber for fencing or a house, and then set fire to the rest (see figure 3).

Once the initial 'land rush' is over and all the land beside the roads has been claimed, tracks and roads leading from the highways will push deeper and deeper into the forest. Soon an area of 50 kilometres either side of the highway will have been destroyed and replaced by small farms or large-scale commercial farms that raise beef or crops for export to the richer countries of the world.

Mining

Many rainforests are growing on land that also contains large energy and mineral deposits such as oil, gold, silver, bauxite, iron ore, copper and zinc (see figure 4). Mineral companies build roads to the deposits and set up large-scale mining and processing plants. These plants require large amounts of electricity, and this is often supplied by burning trees to create charcoal or by constructing vast **hydroelectric dams**.

Deep in the Brazilian rainforest, a 2000-square-kilometre dam has been constructed to provide electricity for aluminium smelters. The dam flooded the entire tribal lands of two native peoples, and is so large that it has altered the climate in the area, making it drier.

Another problem created by mining is the pollution of nearby rivers and streams from chemicals used in the processing plants. Rivers downstream from a vast goldmine in Papua New Guinea have been found to contain four times the safe limit of cyanide in the water. Cyanide is used to extract gold from rock.

ACTIVITIES

IDENTIFY
1 What is the difference between clearfelling and selective logging?
2 List four ***changes***/problems caused by mining operations in rainforests.

EXPLAIN
3 'Many homesteaders are unable to make a good living from the poor tropical soils.' Explain the reasoning behind this statement. You may like to revisit section 6.4 to help you with your response.

INVESTIGATE
4 Refer to figure 1. What percentage of deforestation is caused by agriculture in the Amazon?
5 Using the internet, research any economic activities that are supported by Australian rainforests.

PREDICT
6 As a class, discuss the potential long-term problems that could result from the continued commercial use of rainforest ***environments*** around the world. Develop a list of the top five potential problems.

APPLY
7 Many rainforest ***environments*** are located in developing countries. Why does this make the problem of rainforest destruction harder to solve?
8 Mining companies insist that mining in poorer countries brings benefits to the local community. Re-read section 6.9 on the Huli people of Papua New Guinea, and outline some of the benefits that mining could bring to these people. Then outline any problems that mining could cause for the Huli people. What conclusions can you reach?

6.11 How does deforestation affect the environment and people?

6.11.1 Impacts of deforestation

Deforestation of rainforests around the world is the major cause of problems in this ecosystem. The loss of unique **habitats** is the primary reason species are becoming endangered. Clearing creates smaller islands of vegetation, making it more difficult for animals to communicate and breed. People are also affected by the removal of the rainforest. While indigenous people may feel the effects first, others also experience negative consequences.

habitat the total environment where an animal lives, including shelter, access to food and water, and all of the right conditions for breeding

- About one hectare of rainforest is destroyed every second: this is about twice the size of a soccer pitch.
- Scientists estimate that 137 plants and animals are made extinct daily: that's 50 000 each year. Some haven't even been discovered yet!
- It is believed that in the year 1500 up to nine million indigenous people lived in the Amazon rainforest. The number is now lower than 200 000.
- The world loses about two per cent of its rainforest each year, but rates differ between countries.

Plants and animals

Islands in the forest

Many forests are cleared using fire. These fires will release millions of tonnes of carbon dioxide into the air, increasing the threat of global warming. At the same time, destroying the trees robs the planet of the natural system that helps regulate the amount of carbon dioxide in the air.

In many areas where forests are cleared, it has become a practice to leave behind 'islands' of rainforest. This is meant to assist in the natural regeneration of the forest and also to leave sufficient areas of the natural habitats of plants and animals that live in the rainforest. But is this working?

The islands that are left are often not big enough to ensure the survival of the large numbers of species that live there. For example, the endangered Queen Alexandra's Birdwing (the world's largest butterfly) is facing extinction as its distribution is being

FIGURE 1 The wingspan of the Queen Alexandra's Birdwing can reach 30 centimetres.



condensed into seven isolated blocks of rainforest measuring approximately 1–2 square kilometres in northern Papua New Guinea (see figure 1).

These remaining refuges are threatened by surrounding oil palm plantations.

And there are other problems. When the forest is cleared, the exposed earth can quickly erode as the tree roots no longer hold the soil together, making the regrowth of vegetation slow. On steep slopes this can increase the risk of landslides, and sediments can flow into rivers.

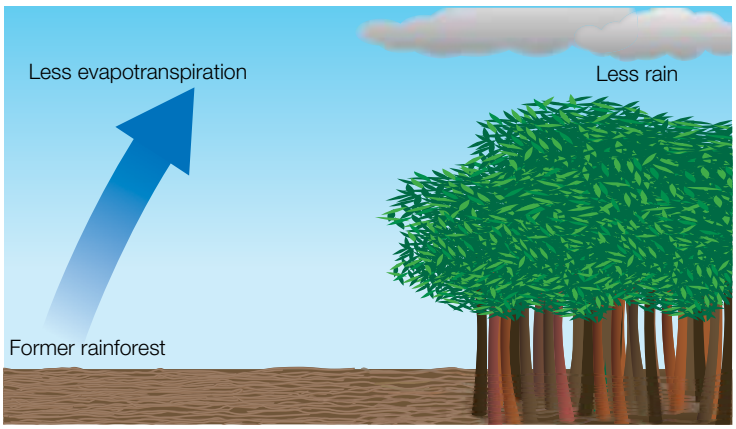
During drought, the bare ground can become hot and barren. With the removal of the forest cover there is little moisture stored in the ground and a much lower rate of **evapotranspiration**. This in turn affects the water cycle, reducing the amount of rain that falls on the remaining islands of rainforest, and they quickly dry out (see figure 2). With the removal of the trees, no nutrients are returned to the soil through decaying leaf litter, which alters the nutrient cycle.

evapotranspiration the process by which water is transferred to the atmosphere from surfaces such as the soil and plants

FIGURE 2 Leftover pockets of rainforest are at risk from reduced rainfall and cannot survive drought conditions.



(a) Rainforest trees are cleared, with 'islands' left for regeneration.



(b) There is less evapotranspiration and less rain on forest 'islands'.

CASE STUDY

Deforestation in Indonesia and the orangutan

Nearly 10 per cent of the world's rainforests and 40 per cent of all Asian rainforests are found in Indonesia. Less than half of Indonesia's original rainforest area remains. Much of this is in Kalimantan, on the island of Borneo. Forests have been cleared for timber, for plantation crops such as palm-oil trees, and to make way for Indonesia's growing population, which is now more than 200 million. Fires lit to clear land in 1982 and 1997 resulted in wildfires that severely damaged large areas of rainforest in Kalimantan. Orangutans, Sumatran tigers and Javan hawk-eagles may disappear from Indonesia as their natural habitats disappear.

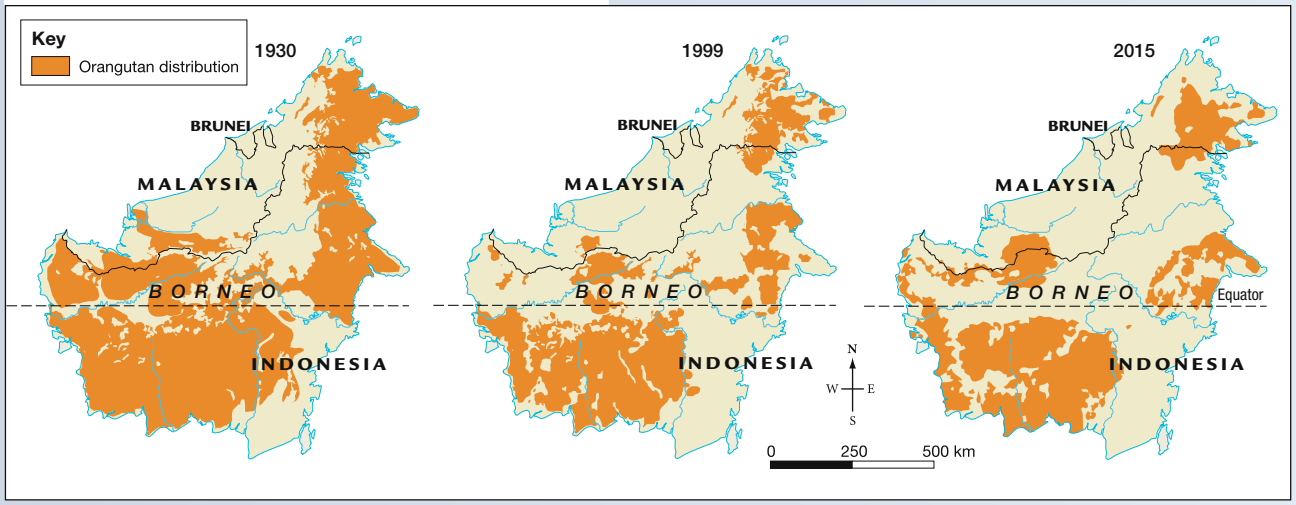
Orangutans are the largest tree-living mammals and the only great ape that lives in Asia. They survive only on the islands of Borneo and Sumatra. Current estimates are that orangutans have lost 80 per cent of their habitat in the last 20 years. In 1997–98, wildfires burned through nearly two million hectares of land in Indonesia, killing up to 8000 orangutans.

It is estimated that orangutan numbers have declined by more than 50 per cent in the last 60 years (see figure 4). The current orangutan population is believed to range between 45 000 and 69 000.

FIGURE 3 Mother and baby orangutan

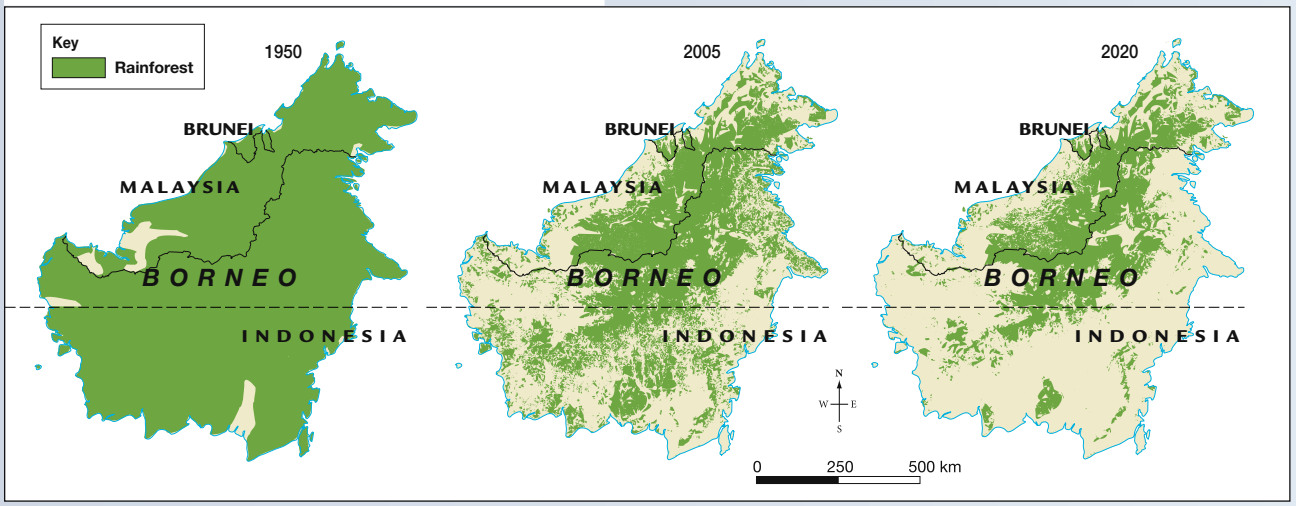


FIGURE 4 Orangutan distribution in Borneo, 1930–2015



Source: IUCN Red list

FIGURE 5 Rainforest distribution in Borneo, 1950–2020



Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Orangutans

People

Indigenous people

As forests are cleared and new settlers move into the region, the indigenous people of the area are often displaced and their culture may disappear. The homesteaders bring new diseases to which indigenous people have no natural immunity. One tribe, the Nambiquara of Brazil, lost half its population to illness when a road was placed through their tribal land. Indigenous people aren't often given a choice about 'progress' coming to their section of the rainforest. As a result, tension can be created between these tribes and the government. In 1999 the Bakun Dam Project began in Malaysia, resulting in the eviction of approximately 10 000 indigenous people from their ancestral homeland. While they were resettled as compensation, the land provided was too small to support their traditional forms of hunting and agriculture and many failed to adapt to their new lifestyles.

Landslides

A landslide, the downward movement of earth and rocks on a slope, occurs in the lithosphere (see section 6.2). It can be caused by natural physical processes such as rainfall and earthquakes, or by man-made activities such as deforestation and road building. Usually, the roots of rainforest plants keep the soil together and add stability to mountainous areas. This is especially important during times of heavier rainfall. However, sometimes the ground becomes so waterlogged that the roots can't keep the soil in place and it slips downhill, creating a landslide. The risk of this increases if deforestation has taken place on the hillside, as there are no tree roots to provide added stability (see figure 6a and b).

FIGURE 6 A forested hillside (a) before and (b) after deforestation

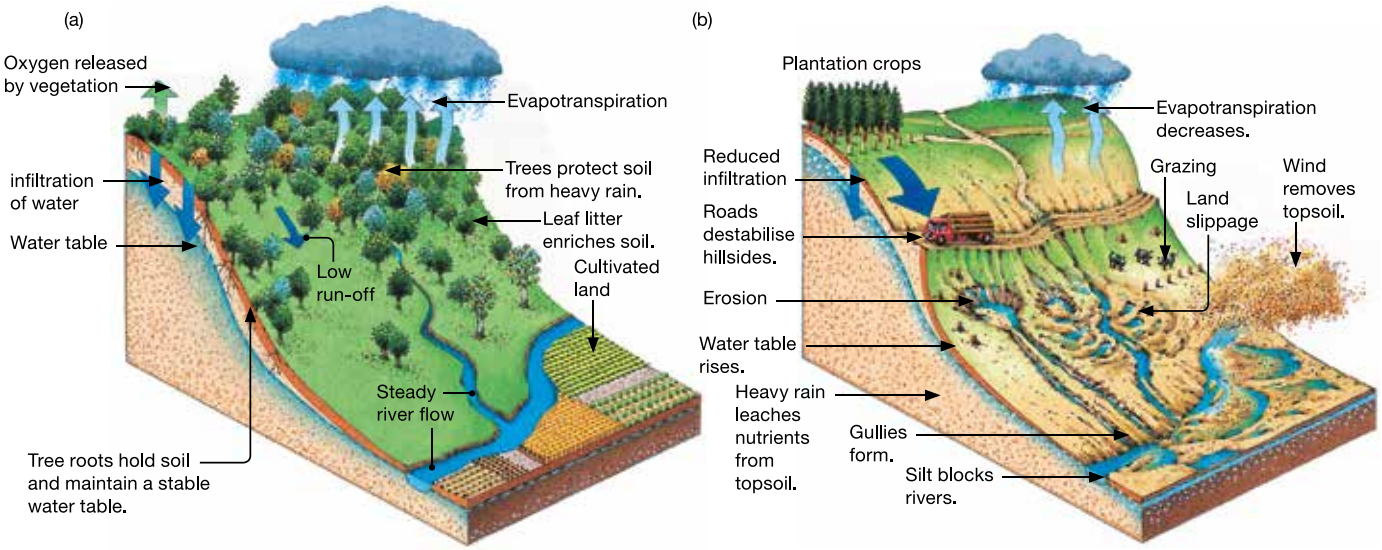


FIGURE 7 Landslides in intact forest in the Mata Atlantica rainforest, Brazil



Therefore, when these hills are cleared and settled by communities, the danger of property damage, and even death, increases. November 2011 saw 35 people killed in a landslide in the Colombian city of Manizales (see figure 8). Fourteen houses were destroyed, displacing up to 159 people. This mountainous, coffee-growing region used to be rainforest before it was cleared and settled.

Haiti is at a high risk of landslides because its people cut down trees to use as fuel. As a result, most of Haiti's natural forest has been destroyed (see figure 9). In 2004, Hurricane Jean hit the island; many of the 3000 people who died were caught in landslides.

FIGURE 8 Landslide in Manizales, Colombia, in November 2011



FIGURE 9 The deforestation in Haiti is clearly evident on its border with the Dominican Republic.



Disease

The arrival of new tropical diseases is a less obvious result of deforestation. As animal **hosts** disappear and new human settlers move into previously inaccessible areas, 'new' disease-causing microorganisms are transferred into the human population. The frequency of mosquito-borne diseases such as malaria has increased due to the creation of more water puddles, for example in ditches and tyre treads, that are an excellent breeding ground for the mosquito. It is estimated that malaria is responsible for the deaths of 20 per cent of the Yanomami people in Brazil and Venezuela. Today, more than 99 per cent of malaria cases in Brazil occur in the Amazon Basin region, even though the mosquitoes that carry the disease are found across 80 per cent of the country.

The outbreak of such diseases doesn't affect only the local area but the impact can also spread into other countries via people who visit these areas, unknowingly contract an illness and then travel home, spreading the disease along the way.

host an organism that supports another organism

ACTIVITIES

IDENTIFY

1 Name some species threatened by deforestation in Indonesia.
2 List the main threats to orangutans.
3 Why does disease affect indigenous people when deforestation occurs?

EXPLAIN

4 How does deforestation affect the lithosphere, atmosphere and biosphere? (Refer to section 6.2 to refresh your memory.)
5 Why does having separate small islands of vegetation make it more difficult for animals to communicate and breed?

INVESTIGATE

6 Refer to figures 4 and 5. Describe the relationship between the two sets of data shown on the maps.
7 Refer to figure 6. Write a paragraph that explains how deforestation results in the consequences illustrated in the diagram.
8 Research and create a list of 10 other animal species threatened by deforestation around the world. Choose one of these animals and report back to the class on its current location, the remaining population level and the main causes of deforestation. Present your report as a poster, PowerPoint presentation, movie (documentary), poem, song or drama performance.
9 Using the internet, investigate two different management strategies/policies/laws that have been implemented around the world to try to conserve the rainforest ***environment***. Note the positive and negative aspects of these strategies. Comment on their ability to support the ***sustainable*** use of rainforests. Discuss your results as a class. Create a summary on the board to evaluate all the options that are shared.

PREDICT

10 Indonesia recently granted a licence to a pulp paper producer to clear 50 000 hectares of forest near an orangutan sanctuary in Sumatra. What impact do you consider this might have on the orangutan population?
11 What could be some of the consequences if the rainforest ***environment*** continues disappearing at its current rate?

APPLY

12 Produce an A4-sized poster designed to publicise the rate and consequences of rainforest destruction. Your poster must include a colourful diagram and a short slogan based on the facts and figures presented in this section.
13 Why is it important to save species from extinction?

eBook*plus*

Interactivity
Deforestation dilemma
Use this interactivity to explore the effects of deforestation.
Searchlight ID: int-3113

6.12 How can rainforests be conserved?

6.12.1 Options for the future

As people begin to realise the importance of rainforests, many have started to work towards preserving these valuable 'green dinosaurs'. Some methods of conservation are relevant only to governments and large companies, but some are relevant to you and the choices you make.

FIGURE 1 The drill, one of Africa's most endangered primates, has a safe haven in the Korup National Park in Cameroon.



Rescue package 1: Protect the remaining rainforests

While only six per cent of the world's rainforests are in a national park or reserve, there are many large areas of rainforest under protection. The number and size of these national parks are slowly increasing. The Korup National Park in Cameroon holds 126 000 hectares of Africa's richest untouched rainforest; the Khao Yai National Park in Thailand has 200 000 hectares, where the habitats of tigers, elephants and gibbons are protected; Costa Rica's rainforests are the most protected of all, with national parks and reserves covering almost one-third of that country.

Rescue package 2: Use the forest without destroying it

sustainable development economic development that causes a minimum of environmental damage, thereby protecting the interest of future generations

This is called **sustainable development**. It means that resources are taken from the rainforests but the forest remains largely intact. It has been estimated that a forest used this way is worth $12 000 a hectare, while it is worth only $300 a hectare if it is cleared for farming.

Timber users can now purchase timber from forests that are properly managed. A company in Mexico — the Forest Stewardship Council (FSC) — assesses forests around the world. If the forests comply with regulations, the timber is given the FSC stamp (see table 1). People who purchase that timber know the forest it came from is being responsibly managed.

TABLE 1 Countries with FSC-certified forests totalling more than one million hectares (2016)

Country	Area of certified forest (hectares)
Australia	1 245 429
Belarus	7 757 520
Brazil	6 176 497
Canada	52 247 475
Chile	2 353 839
China	1 142 911
Congo, The Republic of	2 766 336
Germany	1 053 684
Indonesia	2 186 470
New Zealand	1 257 931
Poland	6 933 317
Romania	2 523 283
Russia	40 752 932
South Africa	1 445 868
Sweden	12 173 649
Ukraine	2 603 965
United Kingdom	1 587 999
United States	13 876 106

Rescue package 3: Use alternative timber

One further step is not to use rainforest timber at all. Many rainforest trees are now grown in plantations, and alternatives such as using steel beams in houses and recycled paper in cardboard help take the strain off the rainforests.

One alternative that has been developed is the processing of old coconut palms to create hardwood. The company that is developing this resource, Tangaloa, claims that there are enough non-productive coconut palms to produce timber equivalent to one million rainforest trees. If this concept proves popular, plantations of coconut palms could be grown specifically for this purpose (see figure 2).

FIGURE 2 Coconut plantation — could these palms help save the rainforests?



Rescue package 4: Act now!

While most of us do not have rainforests growing in our backyards, the choices we make each day can and do make a difference to the way resources are used around the world. There are many organisations that aim to conserve the world's remaining rainforests. Some of their suggestions are:

- use less wood and paper
- write to businesses that destroy the rainforest
- educate yourself about the importance of rainforests
- look for alternatives to rainforest products
- be an **ecotourist** — visit rainforests where your tourist dollars go towards education and conservation.

ecotourist a tourist who travels to threatened ecosystems in order to help preserve them

ACTIVITIES

IDENTIFY

1 What percentage of the world's rainforests are in national parks or reserves?
2 Which country has the most protected rainforests?
3 How are rainforest ***environments*** in Costa Rica protected?
4 Explain in your own words what the FSC does to help protect the rainforest ***environment***.

EXPLAIN

5 List two advantages and two disadvantages of each rescue package. Which of the four packages do you think offers the most hope for rainforest conservation and ***sustainability***? Explain why.
6 Why is it good to have a variety of action options?

INVESTIGATE

7 On a countries outline map of the world, create a choropleth map by shading in those countries with FSC-certified forests of over 100 000 hectares. Use lighter shades of one colour for countries with smaller areas of certified forest (such as 100 000–150 000 and 150 000–200 000 hectares), and darker shades of the same colour for countries with larger areas (250 000–500 000; 500 000–1 000 000; > 1 000 000 hectares).
8 Other methods to help conserve the world's rainforests include:
   - breeding endangered rainforest animals in captivity, and then releasing them
   - providing websites where sponsors can give money to buy some rainforest and put it into a reserve
   - employing indigenous rainforest people to pick nuts and berries or even to breed butterflies for collectors.

   Use the internet to find an example of each of these methods and list any others that you find while completing this research. Document your findings.
9 Design your own website encouraging people to donate money to save the rainforest ***environment***.

eBook*plus*

Interactivity
Protecting or plundering rainforests
Use this interactivity to decide whether or not various strategies protect rainforests.
Searchlight ID: int-3114

6.13 What are the features of the Daintree rainforest?

6.13.1 Daintree rainforest

The Daintree National Park is home to one of the oldest surviving rainforests on Earth. The Daintree rainforest, located in Far North Queensland, is part of the Wet Tropics of Queensland that stretches along the north-east coast of Australia for 450 kilometres. This area was recognised as a World Heritage Area in 1988 for its significance to Australian geological history and biological diversity.

FIGURE 1 Northern Queensland



GEOskills TOOLBOX

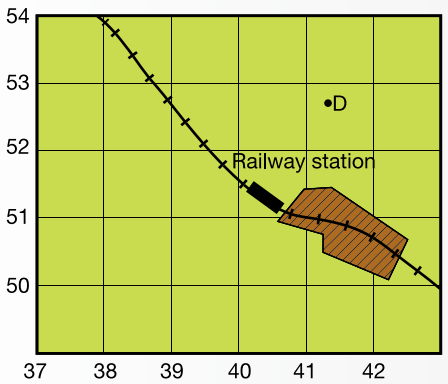
Using area and grid references

Grid lines run up, down and across topographic maps. They can be read the same way that latitude and longitude are read, by looking across the bottom for the number then up the side for the next number.

An area reference is a four-figure number, with AR at the beginning, that tells us the grid square in which to find a feature. The area reference of the railway station in the map below is AR4051.

A grid reference is a six-figure number, with GR at the beginning, that shows an exact point in the grid square. The third and sixth figures represent one-tenth of the distance between the two grid numbers. However, these divisions are not written on the map, so they must be estimated. The grid reference of the D on the map on the right is GR413527.

FIGURE 2 An example of an area and grid reference on a topographic map



ACTIVITIES

APPLY

1 List the types of vegetation that can be seen on the map.
2 List the features found at the following locations.
(a) GR298835 (b) GR298807 (c) GR268831 (d) GR307760
3 Describe what the landscape would look like if you were at the following locations.
(a) GR195768 (b) GR335765 (c) GR272867
4 Which of these locations is the highest: GR252763 or GR301759?
5 Give the six-figure grid references for:
(a) Dayman Point (b) Port of Mossman (c) Miallo.

PREDICT

6 Suggest impacts that the built environment could have on the Daintree.
7 A hotel chain has applied to the Queensland government for permission to build a resort in the Daintree. Assess this proposal from the perspectives of the developers, government, local residents, environmentalists and Kuku Yalanji people. Try to make a decision as to whether this project should be approved. This could be completed in small groups or debated as a class.

FIGURE 3 Topographic map extract of the south-eastern section of the Daintree River National Park



Source: MAPgraphics Pty Ltd, Brisbane

eBookplus ONLINE ONLY

6.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

6.3 SkillBuilder: Understanding thematic maps

6.3.1 Tell me

What is a thematic map?

A thematic map is a map drawn to show one aspect; that is, one theme. For example, the map may show the location of vegetation types, hazards or weather. Parts of the theme are given different colours or, if only one idea is conveyed, symbols may show location.

Why are thematic maps useful?

Thematic maps are used to identify and represent a single feature. No additional clutter is presented on the map — it allows the reader to focus on one feature only.

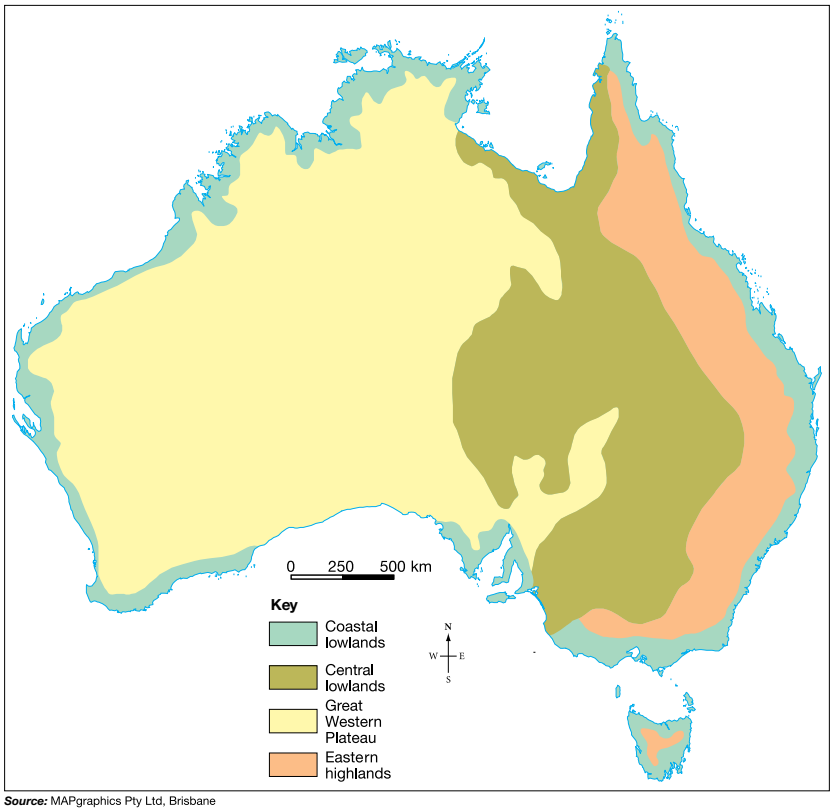
Thematic maps are useful for:

- focusing the viewer's attention on a single feature
- highlighting the significance of a single feature
- comparing different areas of a map in terms of the existence of a feature.

Model

Figure 1a shows four major landform regions. It is a simplified version of a natural features map (figure 1b).

FIGURE 1a Thematic map of the major landform regions of Australia



Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 1b Topographic map of the natural features of Australia



Source: © MAPgraphics Pty Ltd, Brisbane

Much of Australia is dominated by the Great Western Plateau, particularly in the west of the country. Following the coastline are the coastal lowlands, except around the Great Australian Bight and near the Victoria/South Australia border. The eastern highlands run parallel to the east coast from the northern tip of Australia to the south. The central lowlands run from the Gulf of Carpentaria to the Victoria/South Australia border.

A good description of a thematic map:

- utilises the title to identify the theme
- applies the key/legend in order to understand the colouring and/or symbols
- identifies and communicates the key theme and features.

eBook*plus*

eLesson
Understanding thematic maps
Searchlight ID: eles-1658

6.3.2 Show me

How to understand a thematic map

You will need:

- a thematic map
- an atlas.

Procedure:

To understand a thematic map, you must be prepared to follow a planned approach to its study.

STEP 1

Read the title of the thematic map. What part of the world does the map show? When was the data gathered? What is the theme? In figure 1a, the theme is 'major landforms in Australia'.

STEP 2

Check that the map was put together by a reliable authority. Who is the source of the map? Sometimes textbooks don't state the source. However, you can usually find this information by looking at the list of acknowledgements in the book.

STEP 3

Read the key/legend to understand the colours and/or symbols that are being used. In figure 1a, four different colours are used to represent each of the four major landforms.

To interpret the colours you need to comment on where the various colours or symbols occur. Can you discuss the map by continent, or by region? An atlas may be useful to help you identify regions or places. In figure 1a, the eastern highlands stretch from the north of Australia to the south, parallel to the coastline.

STEP 4

You also need to discuss the colours or symbols that appear only in small areas of the map. In figure 1a, the central lowlands reach to the coast near the Victorian/South Australian border and the Great Western Plateau meets the coast in the Great Australian Bight.

eBook*plus*

Interactivity
Understanding thematic maps
Searchlight ID: int-3154

6.3.3 Let me do it

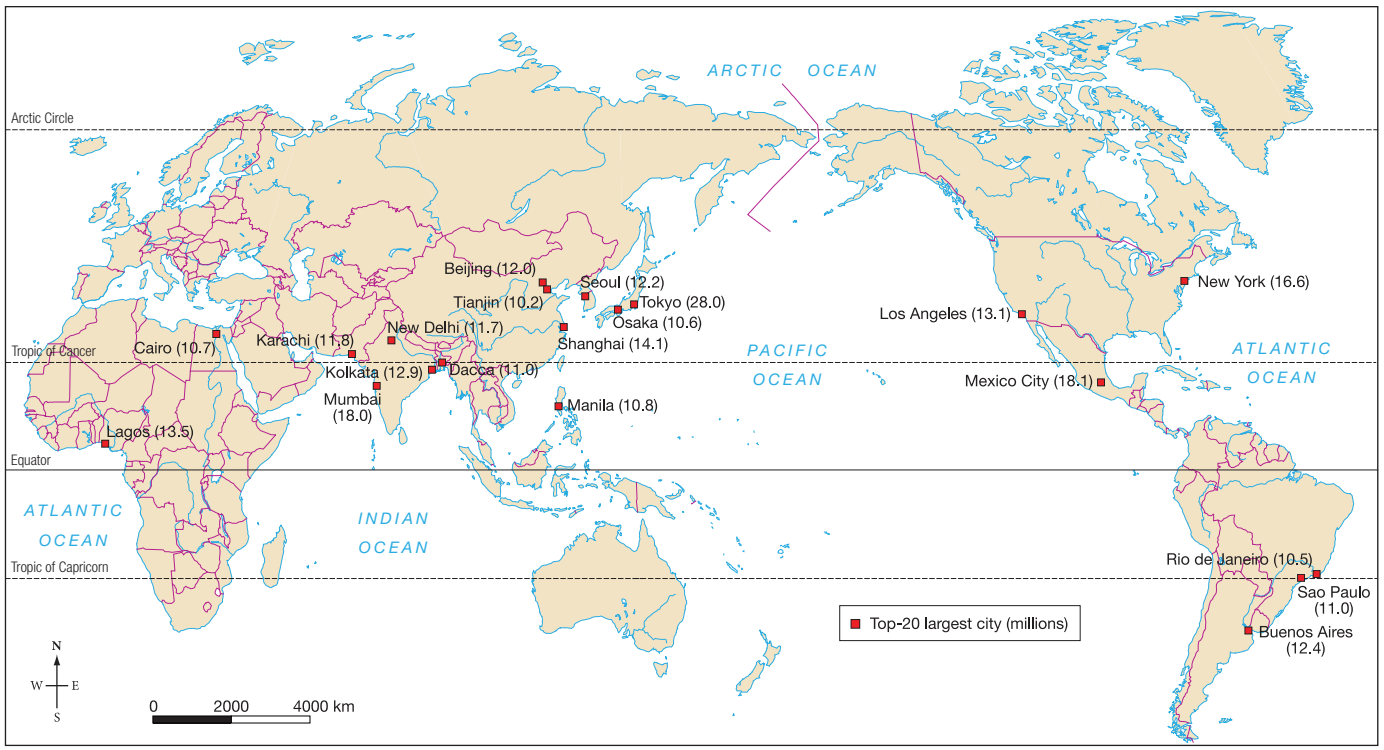
Developing my skills

Using figure 2, describe the locations of the world's 20 largest cities.

Questions

1. What is the title of the map in figure 2?
2. What theme is being shown in figure 2?
3. In which continent are most of the 20 largest cities located?
4. Which continents contain none of the 20 largest cities?
5. How many people live in the three largest cities in South America?

FIGURE 2 The world's 20 largest cities



Source: MAPgraphics Pty Ltd, Brisbane

Checklist

I have:

- utilised the map title to identify the theme
- applied the key/legend in order to understand the colouring and/or symbols
- identified and communicated the key theme and features.

Skills questions

1. Thematic maps are used to show:
   a. the interconnection between places
   b. the shape of the land between two places
   c. a set of ideas
   d. one key idea.
2. A thematic map provides:
   a. totals of information
   b. quality of information
   c. percentages of information
   d. summarised information.
3. Why is a range of colours used on a thematic map?
4. Why are thematic maps quite simple maps?

6.5 SkillBuilder: Creating and describing complex overlay maps

6.5.1 Tell me

What is a complex overlay map?

A complex overlay map is created when one or more maps of the same area are laid over one another to show similarities and differences between the mapped information. All maps must be at the same scale. Laid over a base map with information that is consistent (for example, landforms), traced copies of maps showing variables (for example, population) allow you to see the elements underneath. Traditionally, the second map is on tracing paper that is attached to the original page.

Why are complex overlay maps useful?

Complex overlay maps are analysed to show relationships between factors — the similarities and the differences in a pattern. They are useful when looking for the degree to which features are arranged in a similar pattern. In a complex overlay map there may be three or more layers, allowing three or more variables to be compared. Complex overlay maps also help you work out between which features there is the strongest or weakest relationship or interconnection.

In today's world of computers, Geographic Information Systems (GIS) programs do this task. Layers on the computer screen can be turned 'off' and 'on' to show the interconnection between factors in a distribution pattern.

Complex overlay maps are useful for:

- town planners to see new settlement patterns overlaid on the land's shape
- construction engineers to see original buildings and the interconnection of extensions to a building
- logistic engineers to overlay the distribution of a number of features to identify similarities
- farmers to seek alternative planting rotations with an increased knowledge of the features involved, such as soil types, rainfall and topography.

Model

This sample complex overlay shows a map of Australia's drainage catchments used as the base map (centre in figure 1). Taped to this on tracing paper is a map of Australia's average annual rainfall shown at right in figure 1, attached so as to be able to fold onto the base map. Also taped to the base map, from the opposite side, is a map of Australia's seasonal rainfall patterns, shown at left in figure 1. This is also attached so as to be able to fold onto the base map. Additional layers could be added by taping further maps (drawn on tracing paper) to the top and bottom of the base map.

This series of map overlays provides an example of interconnection; in this case, the interconnection between annual rainfall and seasonal rainfall, between annual rainfall and drainage catchments, and between seasonal rainfall and drainage catchments.

Further analysis is required to show areas that are not connected and areas that are sometimes related, but not always. For example, the Murray–Darling Basin drainage catchment has a wide range of seasonal rainfall patterns across its area, varying from uniform rainfall to arid zones.

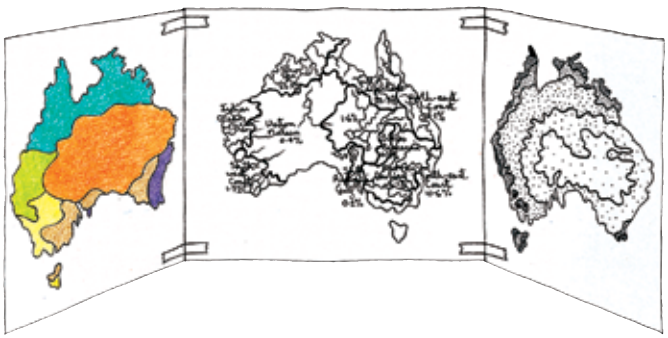
A good series of complex overlay maps has:

- been drawn in pencil first, then coloured
- been drawn in light colours, so that the base map remains obvious
- a key/legend on each overlay, offset so each can be seen
- been accurately taped together so the maps overlap exactly
- labelled features, if necessary
- included BOLTSS.

A clear description of complex overlay maps has:

- the same area/location on each of the three or more maps overlaid accurately
- identified and communicated key features
- clearly represented and communicated the data.

FIGURE 1 An illustration of a completed complex overlay map showing Australia's seasonal rainfall patterns (left), drainage catchments (centre) and average annual rainfall (right)



eBookplus

eLesson
Creating and describing complex overlay maps
Searchlight ID: eles-1656

6.5.2 Show me

How to create and describe a complex overlay map

You will need:

- three maps of the same region at the same scale showing different information
- one of these maps to act as a base map
- two pieces of tracing paper, at least as large as the base map
- a light grey pencil
- coloured pencils
- a ruler
- an eraser
- adhesive tape.

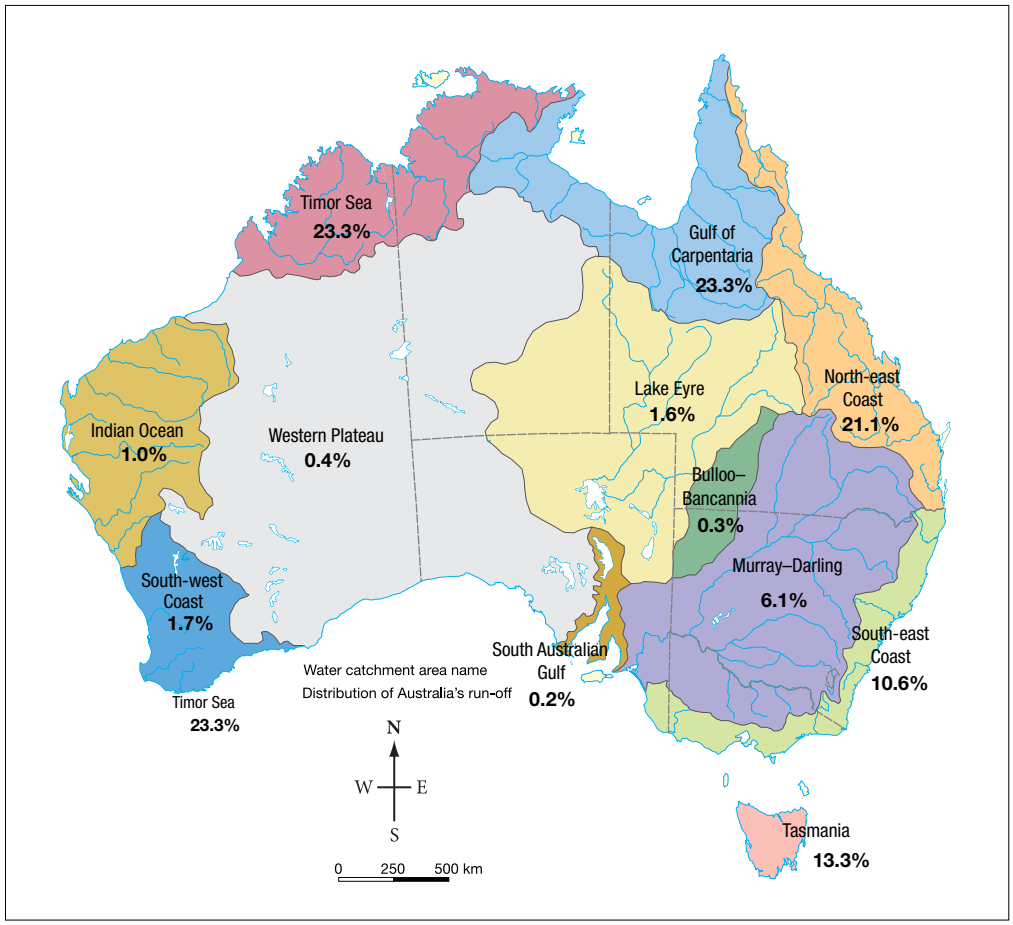
Procedure:

To complete and describe complex overlay maps you must have two or more maps of the same place and at the same scale with different information.

STEP 1

Select the base map — this will show information that is unlikely to vary. In this instance, it is the drainage catchments. You may need to trace the base map if it appears in a book, as it may not be possible to stick other maps to the original.

FIGURE 2a Australia's drainage catchments

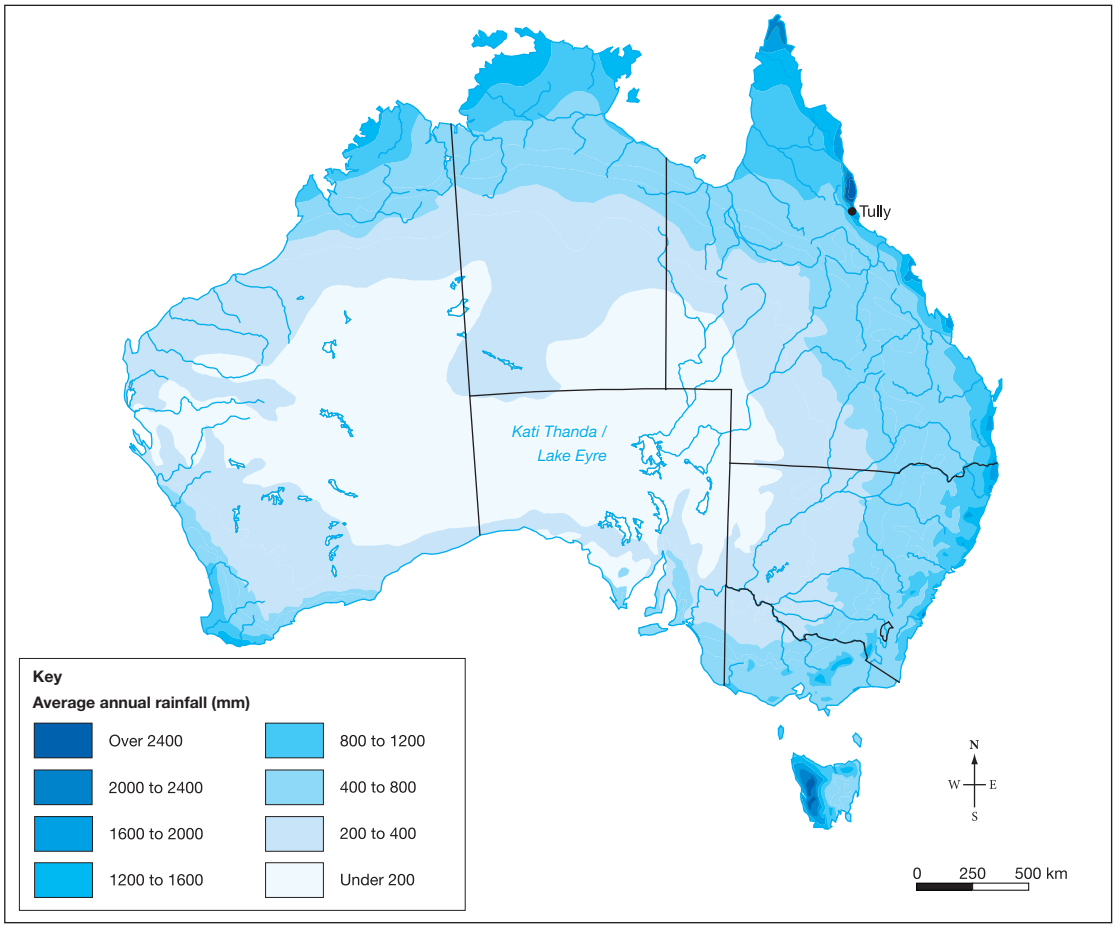


Source: MAPgraphics Pty Ltd, Brisbane

STEP 2

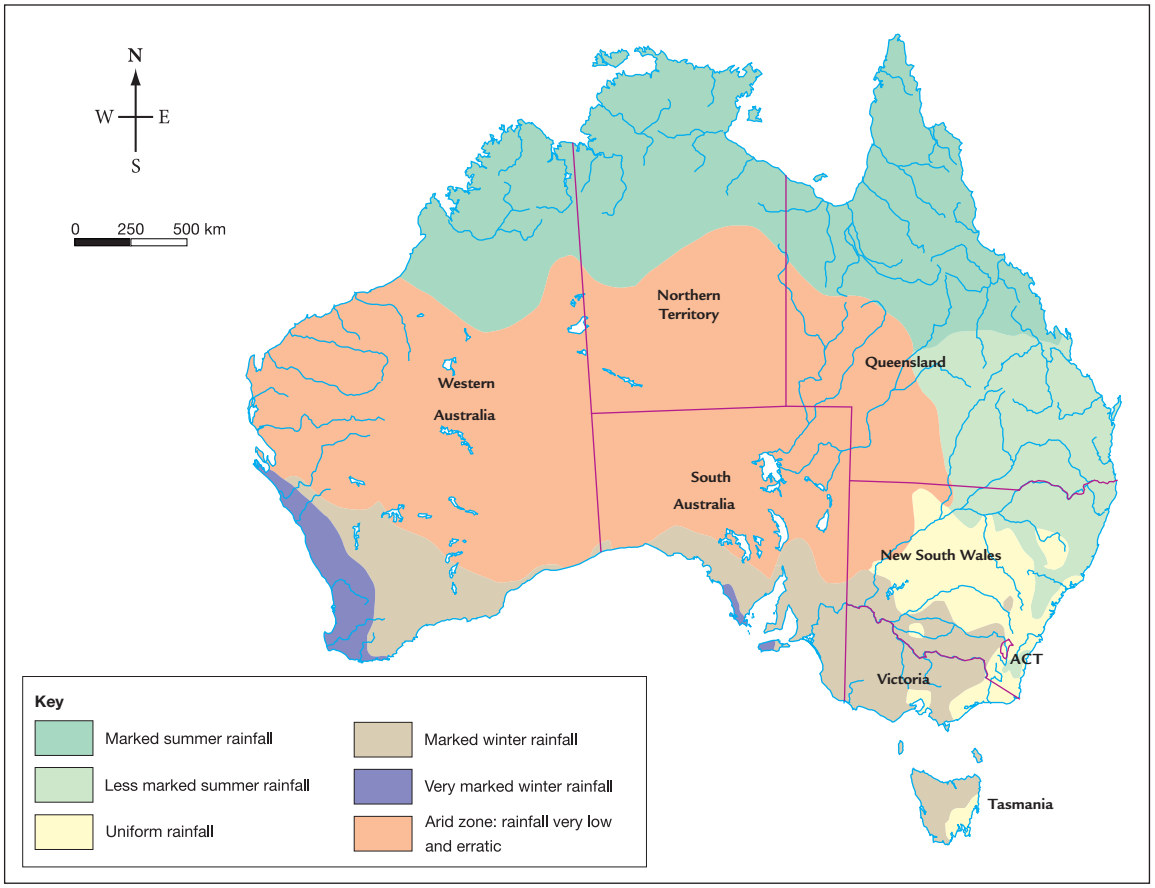
Trace each of the other maps onto separate sheets of tracing paper.

FIGURE 2b Australia's average annual rainfall



Source: Bureau of Meteorology, 2003, on the Australian Water Map, Earth Systems Pty Ltd

FIGURE 2c Australia's seasonal rainfall patterns

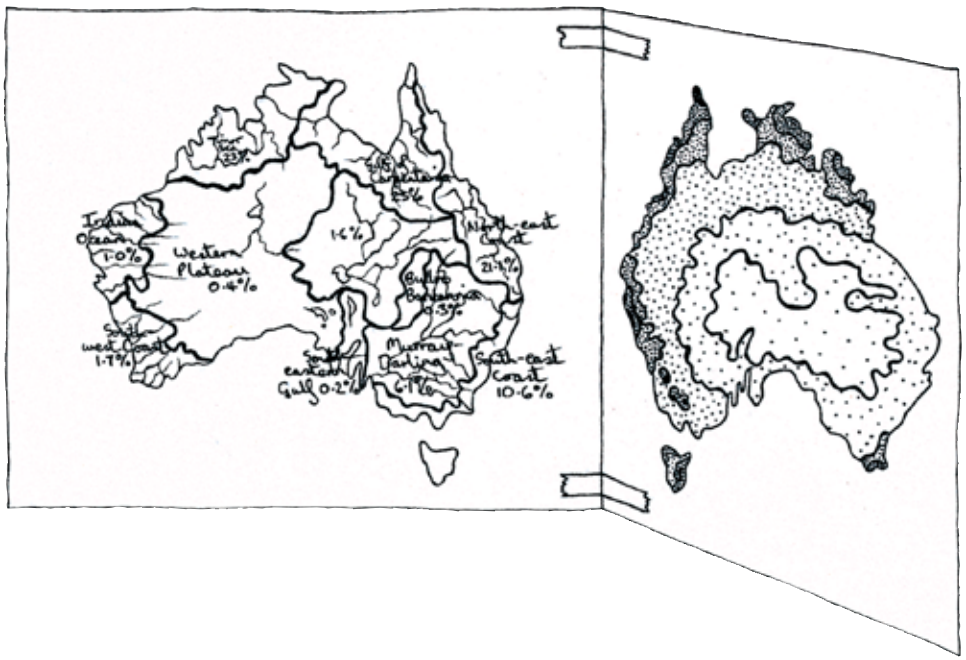


Source: MAPgraphics Pty Ltd, Brisbane

STEP 3

Using adhesive tape, hinge the maps to fold on top of each other so that the map outlines (coastlines) match up. Alignment is very important, so choose obvious borders to line up. Figure 3 shows the hinged maps.

FIGURE 3 Hinged map (first overlay) over base map



STEP 4

You are now able to lift each map separately from the others to see the information individually, or view two or more maps combined.

STEP 5

To finish your maps, don't forget to include BOLTSS. Each map should have its own title, its own key/legend and its own source. Scale and north pointer need to appear only on the base map.

FIGURE 4 Two maps hinged to a base map, forming a complete overlay map shown prior to folding.



STEP 6

To analyse the information that the overlay maps show, you comment on where there is a relationship or interconnection of features. Lay any two maps together and identify any similar patterns. Write a sentence about these similarities. Then lay all three maps together, identify any similar patterns and write a sentence about these. An example is that the area with less than 400 mm of rainfall forms the arid zone, with erratic rainfall across the Western Plateau and Lake Eyre catchments.

STEP 7

Next, look for significant differences across two maps. Write a sentence about these differences. Then look for significant differences across the three maps and write a sentence about these. For example, the very marked winter rainfall in south-west Western Australia does not produce greater annual rainfall than that in western Tasmania and near Tully, Queensland.

STEP 8

Now go through the process again looking for unusual occurrences; that is, where things appear random and show no interconnection. An example is that the Murray–Darling Basin drainage catchment has a wide range of seasonal rainfall patterns across its area, varying from uniform rainfall to arid zones.

eBook*plus*

Interactivity
Creating and describing complex overlay maps
Searchlight ID: int-3152

6.5.3 Let me do it

Developing my skills

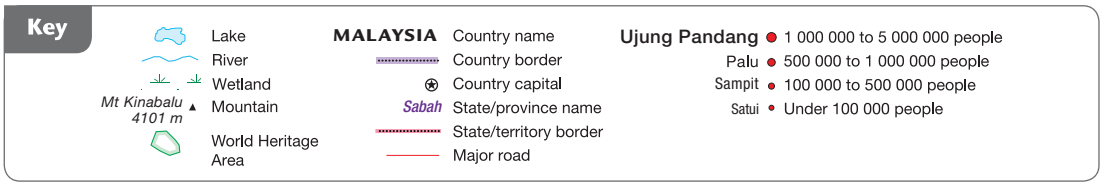
Use the images from figures 4 and 5 in the case study in subtopic 6.11 showing orangutan distribution in 2015 (right-hand map in figure 4) and rainforest distribution in 2005 (centre map in figure 5), along with figure 5 (on the next page) showing the topography of Borneo. Create an overlay map to show the interconnection between topography, rainforest distribution and orangutan distribution.

Note: You will need to make your base map (from figure 5) the same scale as the maps in the textbook. To do this, draw a 3 × 3 grid over the base map, then draw a smaller 3 × 3 grid on a piece of paper — this new grid should be the same size as the maps from the textbook that you want to match. Working one grid square at a time, sketch a copy of the base map into the new smaller grid.

FIGURE 5 Topography of Borneo



Source: Spatial Vision



Questions

1. Is there a pattern (relationship or interconnection) between the location of the highest land and rainforest distribution (2005) in Borneo?
2. Is there a pattern (relationship or interconnection) between the location of rainforests (2005) and the distribution of orangutans (2015) in Borneo?
3. Are there any areas in Borneo where there is no relationship between rainforest distribution and orangutan numbers?
4. On what type of land might rainforests be found in the future?
5. Between which two features is the strongest relationship?
   - High land and rainforest distribution
   - High land and distribution of orangutans
   - Rainforest distribution and the orangutan population. What would explain this strong relationship?

Checklist

I have:

- drawn in pencil first, then coloured
- used light colours, so that the base map remains clear
- placed a key/legend on each overlay, but offset it so each can be seen
- created hinges with adhesive tape at appropriate spots
- labelled features, if necessary
- included BOLTSS.

Skills questions

1. Overlay maps are most useful to:
   a. compare two or more different features on a map
   b. investigate rainfall
   c. illustrate statistics
   d. show only one feature about a place.
2. Interconnection is used to:
   a. describe the distance between two objects
   b. describe the location of a single place
   c. describe to what extent features are found in a similar distribution pattern
   d. map information.
3. Why should you use light colours on the overlay of a map?
4. Why is it important to include BOLTSS on the base map?

6.7 How is the Amazon rainforest changing?

6.7.1 The Amazon rainforest

The world's largest remaining rainforest is in the Amazon **Basin** in South America. This truly remarkable forest is under increasing threat from forestry, mining and farming. The loss may cause severe problems worldwide. Most of us use rainforest products every day. More importantly, however, rainforests help control the world's climate and our oxygen supply. So the next time you eat chocolate, treat your asthma, play a guitar or even take a deep breath, you should thank the Amazon rainforest.

basin drainage basin; the total area drained by a river and its tributaries

FIGURE 1 The Amazon Basin



Source: MAPgraphics Pty Ltd, Brisbane

A The Amazon River and those rivers that feed into it (tributaries) contain one-fifth of the world's fresh water, and more than 2000 species of fish — more than in the Atlantic and Pacific oceans combined.

B The mouth of the Amazon River is approximately 325 kilometres wide and contains an island the size of Switzerland!

- The Amazon forest is home to more than 40 000 species of plants, 1300 bird species, 430 different mammals and 2.5 million different insects.
- Approximately 1.3 million tons of sediment is transported by the Amazon River to the sea daily.
- No bridges cross the main trunk of the Amazon River, which locals call the Ocean River.
- Since 2000, the Amazon rainforest has been facing deforestation at an average rate of 50 football fields per minute.
- The Amazon is the second longest river in the world, but it carries more water than the next six largest rivers combined.
- The Amazon River drains nearly 40 per cent of South America.
- There are official plans for 412 dams to be in operation in the Amazon River and its headwaters.
- Since 1900, more than 90 indigenous groups have disappeared in Brazil alone.

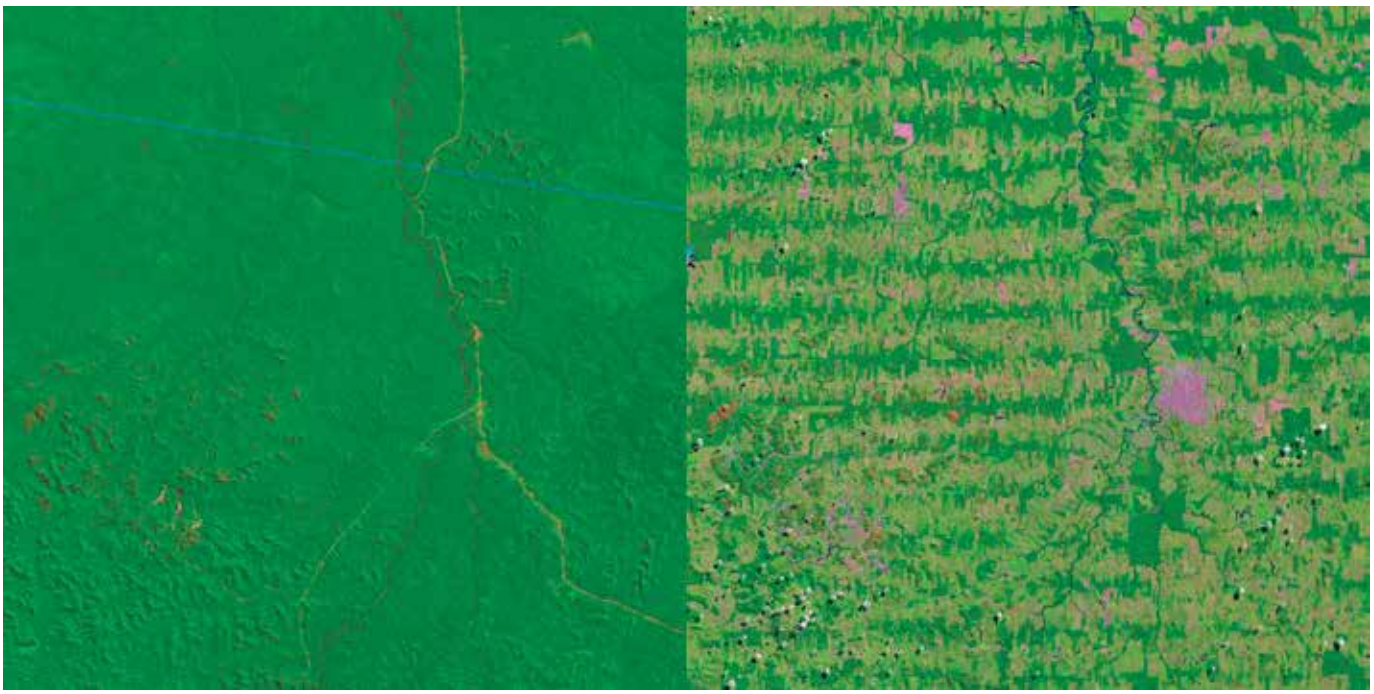
FIGURE 2 The brown waters of the Amazon show that it is carrying a lot of sediment.



FIGURE 3 Area cleared for ranching in the Amazon rainforest

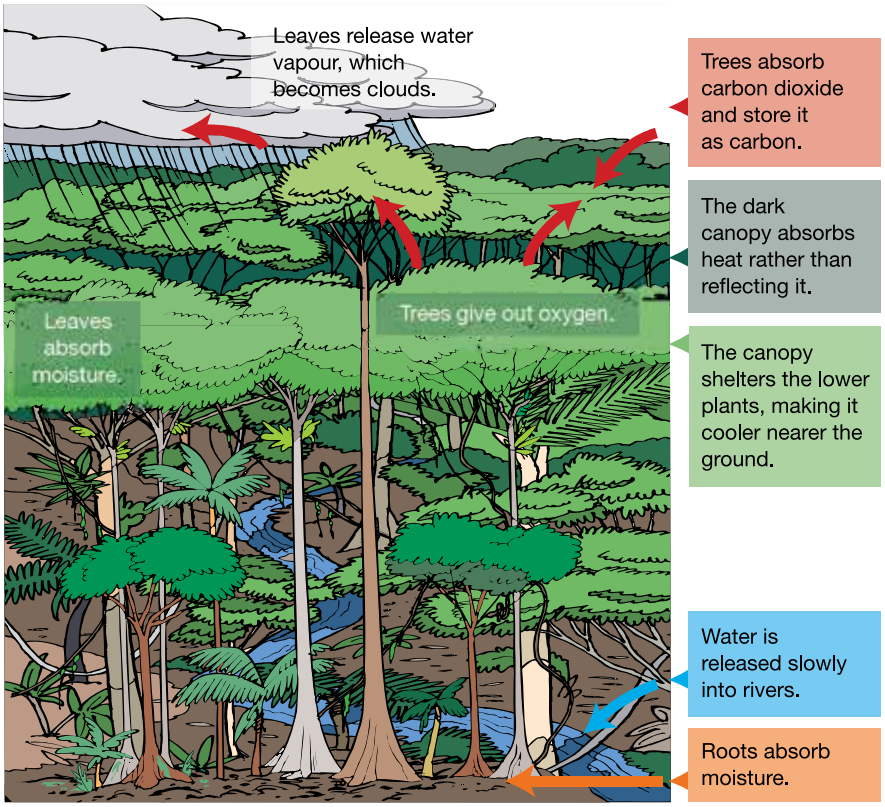


FIGURE 4 Development is clearly visible within the green carpet of the Amazon rainforest between 1975 (left) and 2012 (right).



Source: NASA/Landsat

FIGURE 5 Rainforests play a vital role in controlling the world's climate and oxygen supply. Scientists believe that half of all the world's oxygen is produced by the Amazon rainforest alone.



6.7.2 Amazing rainforests

- More than 7000 modern medicines are made from rainforest plants. They can be used to treat problems from headaches to killer diseases like malaria. They are used by people who suffer from multiple sclerosis, Parkinson's disease, leukaemia, asthma, acne, arthritis, diabetes, dysentery and heart disease among many others.
- Even animals can be used to cure human diseases. Tree frogs from Australia give off a chemical that can heal sores, and a similar chemical from a South American frog is used as a powerful painkiller.
- The poisonous venom from an Amazonian snake is used to treat high blood pressure.
- Only one per cent of the known plants and animals of the rainforest have been properly analysed for their medicinal potential. Perhaps the greatest benefits to medicine and our own health, however, are yet to come.
- Rainforests are home to the greatest profusion of life on the planet: at least half of all known plants and animals live in rainforests.
- At least 50 million indigenous peoples live in rainforests worldwide. From the Kuna people of Panama and the Yanomami of Brazil to the Baka people of Cameroon and the Penan of Borneo (Indonesia), these people have traditionally lived a way of life that has little impact on their forest home.

FIGURE 6 Skin secretions from frogs such as the Waxy Monkey Treefrog (*Phyllomedusa bicolor*) contain powerful painkillers.



- The people who live in or near the rainforests gain much of their food from the forest. But rainforests also supply the supermarkets of the world with their bounty. Most of these fruits and nuts are now grown by farmers rather than harvested directly from the forest, but it was in the rainforests that they originated.
- Chocolate first came from cacao trees native to the Amazon rainforest. Today the cocoa in the chocolate you eat is most likely to have come from huge cacao plantations in West Africa. Similarly, brazil and cashew nuts, cinnamon, ginger, pepper, vanilla, bananas, pineapples, coconuts, paw-paws, mangoes and avocados were all originally rainforest plants. Even the gum used in chewing gum comes from a rainforest plant, as does the tree that produces rubber.
- Rainforest trees are generally hardwood trees, making them resistant to decay and attractive for building. Well-known rainforest timbers are mahogany, teak, ebony, balsa and rosewood. Rosewood is particularly interesting, as it is considered the best timber in the world for guitar making. In many tropical countries, people also collect timber as fuel for cooking or heating.

FIGURE 7 The Kamayurá people of the Brazilian rainforest live a traditional way of life.



FIGURE 8 Food products such as chocolate and chewing gum are made from ingredients that originally came from the rainforest.



ACTIVITIES

EXPLAIN

1 Which of the present uses of the rainforest do you think is the most ***sustainable*** for the forest's future? Explain your answer.

2 Refer to figure 4. Why does the clearing and ***change*** in the Amazon appear to occur in straight lines?

3 Looking at figures 2, 3 and 4 for ***interconnections***, what do you think could be contributing to the high levels of sediment in the Amazon River? Why?

4 Refer to figure 5.
- **a** Explain the role of the rainforest environment in relation to the climate.
- **b** Why are rainforests sometimes called 'the lungs of the Earth'?

INVESTIGATE

5 Look carefully at figure 1.
- **a** List the countries of South America into which the Amazon rainforest extends.
- **b** Which country contains most of the Amazon rainforest?
- **c** Why do you think there are so few large cities in the rainforest?
- **d** Estimate the percentage of the rainforest that can be considered:
  - **i** under low or no threat
  - **ii** under threat
  - **iii** disturbed.

Describe in your own words what each of these terms means.

6 Using a piece of tracing paper, trace the Amazon River and its tributaries. Draw a single line that joins the source of each of the tributaries. Shade the area within this line using a light blue pencil: this area is known as the **catchment**, or basin, of the river. Overlay your completed diagram on the map of the forest and comment on the ***interconnection*** between the river and the forest.

7 This subtopic lists only a few of the products we use from rainforests. List the value of these and other rainforest products under the following headings.
   - **a** Valued by different cultures
   - **b** Valued economically
   - **c** Valued for its aesthetic value (beauty)
   - **d** Other

8 Use the **Treehouse** weblink in the Resources tab (click on the picture then choose the *Track it back* activity) to learn how the food you eat comes from the rainforest.

9 Use the **Amazon tour** weblink in the Resources tab to take a tour through an Amazon rainforest slideshow.

APPLY

10 If development in the Amazon Basin continues as seen in figures 3 and 4, what could be the consequences in terms of the processes shown in figure 5?

11 Make a list of things in your home that may come from the rainforest ***environment***. Remember to look in the medicine cupboard and the pantry as well as at the furniture. Perhaps you could bring some examples to school and your class could set up a display.

catchment area of land that drains into a river

eBook*plus*

Weblinks
- Treehouse
- Amazon tour

6.8 SkillBuilder: Drawing a précis map

6.8.1 Tell me

What is a précis map?

A précis map is a simplified map — the cartographer has decided which details to leave in and which to leave out. It is different from a sketch map, which includes all the main features.

Why are précis maps useful?

A précis map is a summary of an area. There may be just one feature shown, such as rainforest. Sometimes more features are shown, such as vegetation, urban areas and roads.

They are also useful for:

- identifying a particular feature or features, such as rainforests or residential/industrial areas of a city
- close examination of a particular feature
- focusing the reader's attention on a feature, such as the distribution of a plant species
- showing or including detail not visible on a satellite image or aerial photograph.

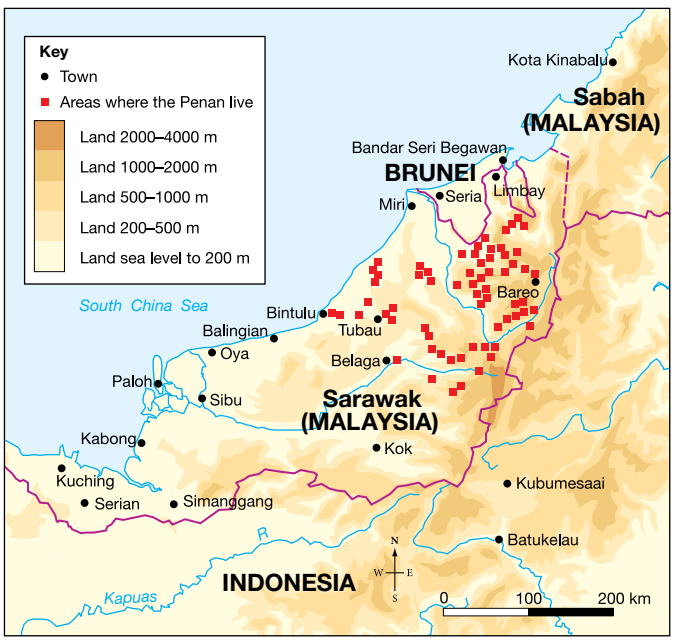
Model

The map in figure 1 shows four aspects — the height of the land, the major towns, the rivers and the areas where the Penan people live. The cartographer has elected to omit aspects such as transport systems and vegetation. The areas in which the Penan people live have been drawn as symbols and in no way depict the boundaries of their locations. Figure 1 is a précis of the complex map in figure 2.

A good précis map has:

- been neatly presented
- been drawn in pencil
- been coloured or shaded and includes a key/legend
- accurately shown a feature or features
- included BOLTSS.

FIGURE 1 Précis map showing Sarawak, in Malaysian Borneo



Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 2 Complex map showing Sarawak, in Malaysian Borneo



Source: Spatial Vision

Key

- Lake
- River
- Wetland
- Mt Kinabalu 4101 m — Mountain
- World Heritage Area
- MALAYSIA — Country name
- Country border
- Country capital
- Sabah — State/province name
- State/territory border
- Major road
- Ujung Pandang — 1 000 000 to 5 000 000 people
- Palu — 500 000 to 1 000 000 people
- Sampit — 100 000 to 500 000 people
- Satui — Under 100 000 people

eBook*plus*

eLesson
Drawing a précis map
Searchlight ID: eles-1657

6.8.2 Show me

How to draw a précis map

You will need:

- a map of the region being considered
- a light grey pencil
- coloured pencils
- a ruler
- an eraser.

Procedure:

STEP 1

Determine the area that you want to use to create a précis map. In figure 1 this has been done by removing details for surrounding countries, so that only Sarawak is detailed. Figure 1 is a précis map of figure 2.

STEP 2

Rule a border on your page within which to create your map. Make this the same size as the original to avoid having to scale your drawing.

STEP 3

Identify the feature/s and their extent that you are going to include on your précis map. In figure 1, the cartographer has chosen to leave in land heights, rivers and towns, and has chosen to leave out roads and vegetation.

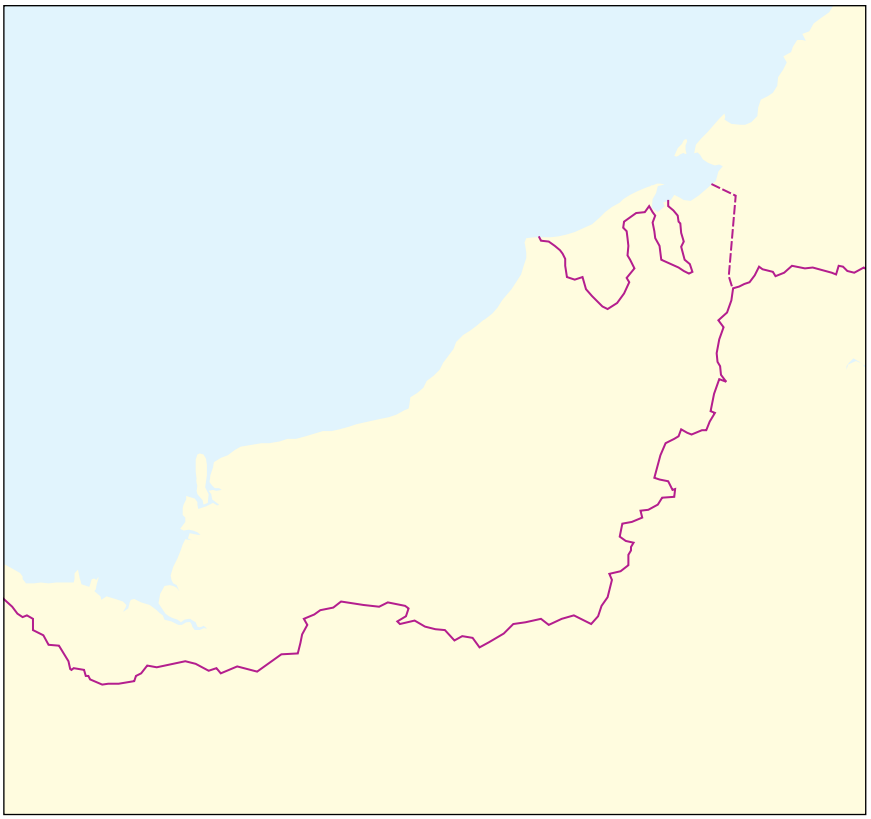
STEP 4

Create a colour-coded key/legend for each feature and place it next to or below the map.

STEP 5

Within the border that you created in step 2, draw an outline of the area that is to be mapped. Retain the scale of the original map that you are using.

FIGURE 3 Setting up the base map for the précis map



STEP 6

Individually, take each of the features that you identified in step 3 and mark onto your map, in a generalised way, the area that it covers. When you have completed one feature, colour it before moving to the next feature and mark your key/legend appropriately (see figures 4, 5, 6 and 7). It will prevent confusion if you complete the colouring as you go, rather than leaving it all until the end.

FIGURE 4 Land heights have been added to the base map.

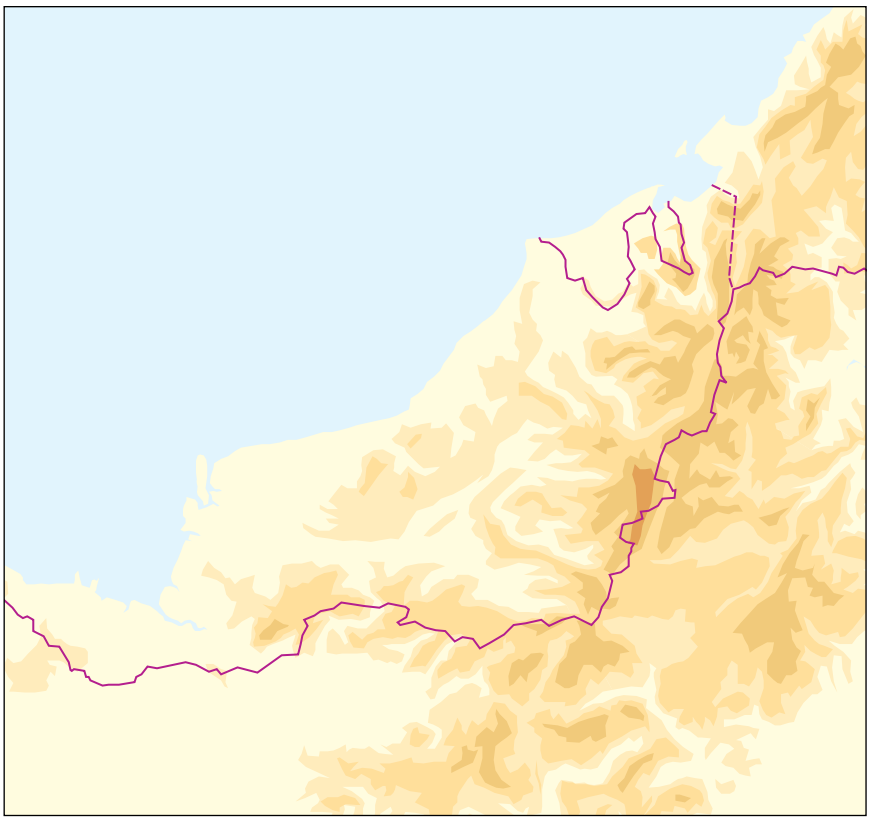


FIGURE 5 Rivers have been added to the base map.

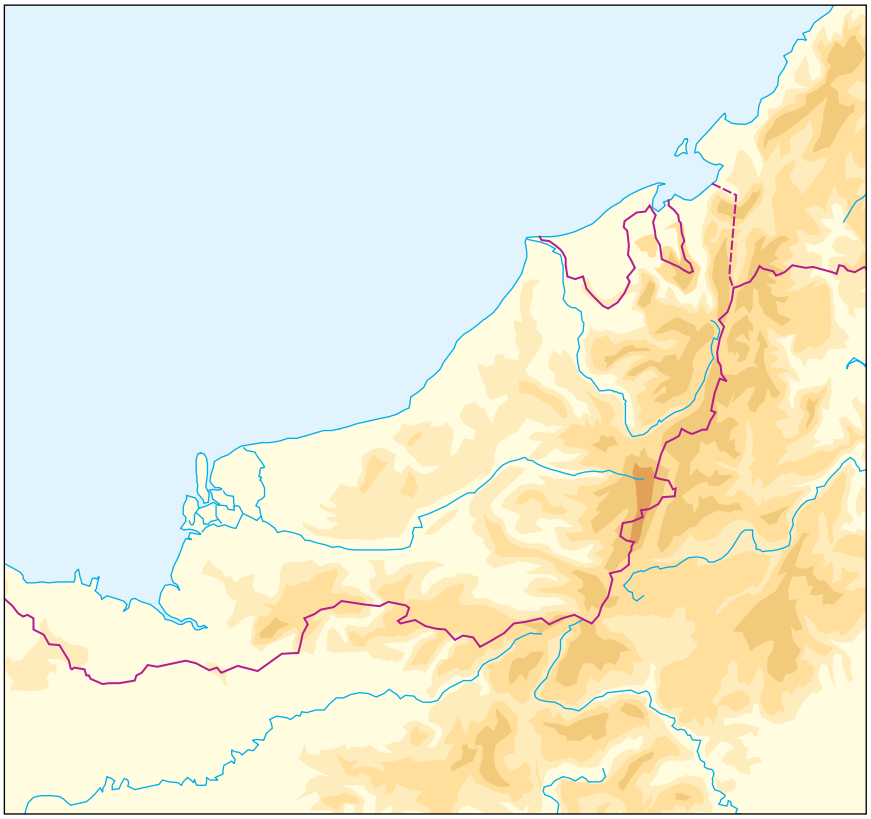


FIGURE 6 Towns have been added to the base map.

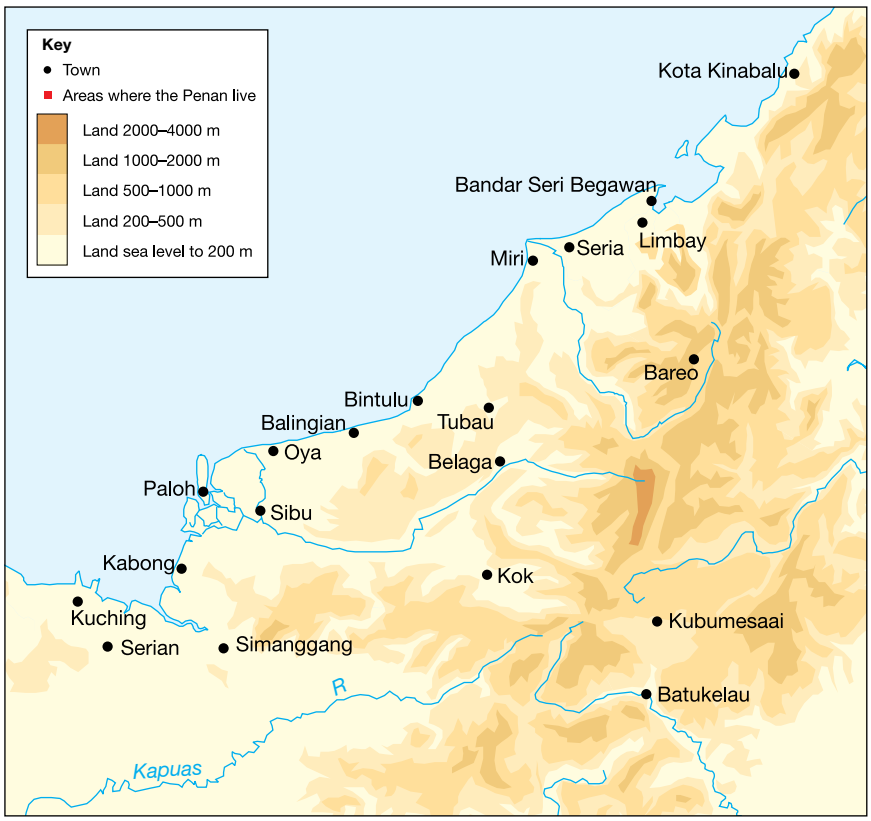
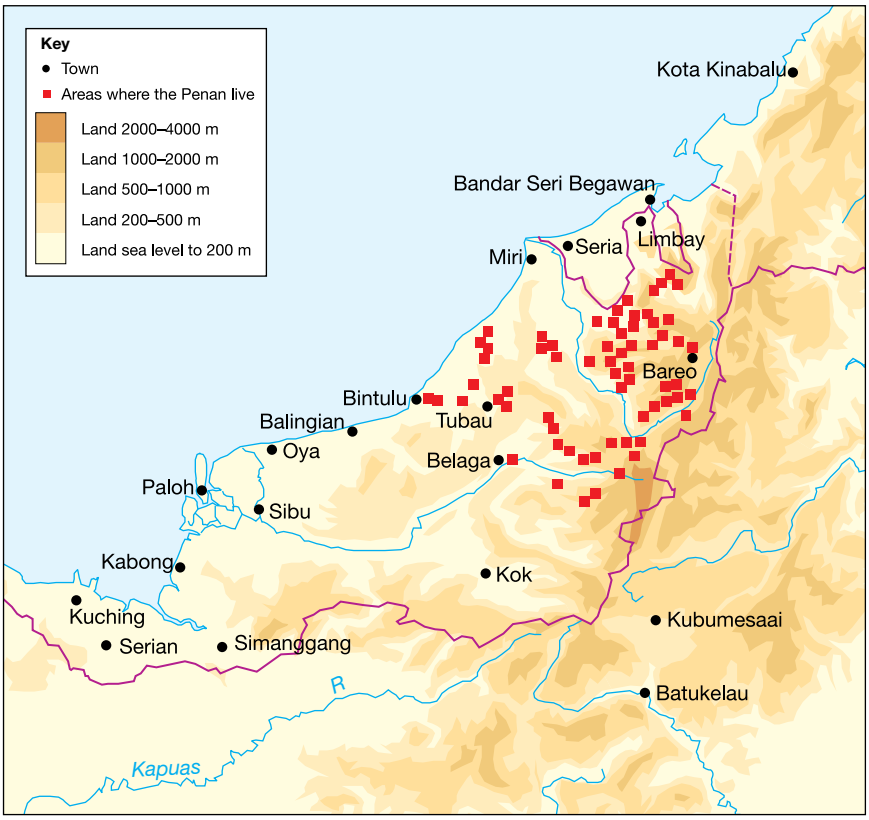


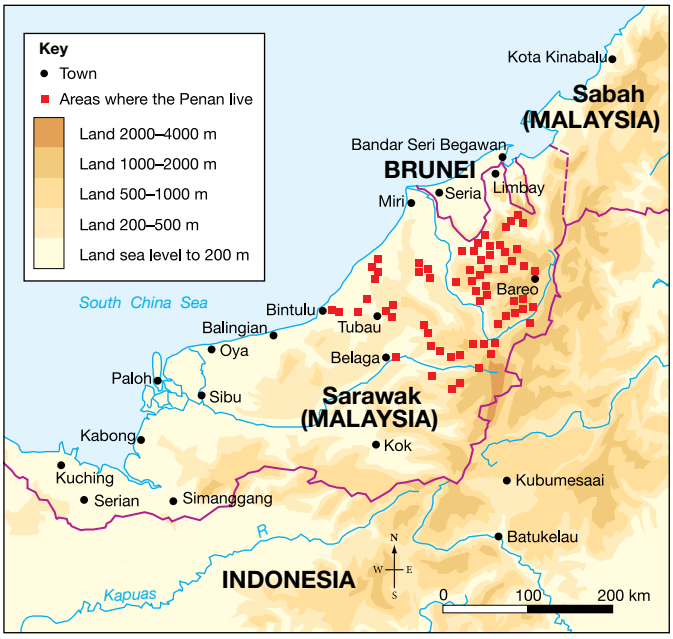
FIGURE 7 The locations of Penan lands have been added to the base map.



STEP 7

Complete the précis map with BOLTSS.

FIGURE 8 Completed précis map



Source: MAPgraphics Pty Ltd, Brisbane

eBookplus

Interactivity
Drawing a précis map
Searchlight ID: int-3153

6.8.3 Let me do it

Developing my skills

Refer to the map of the Amazon shown in figure 1 in subtopic 6.7. On a separate piece of paper, create a précis map showing only the levels of deforestation. Map the outline and include the borders of countries. To show levels of deforestation, you should include the areas of undisturbed natural forest (low or no threat), undisturbed natural forest (under threat) and disturbed forest.

Ensure that you complete the conventions of good mapping — include BOLTSS.

Questions

1. What level of deforestation dominates the Amazon Basin?
2. Is there more area of forest under threat than there is deforested area?
3. Is there a greater area of forest under threat than there is not threatened?
4. In which area of the Amazon Basin is the majority of the least disturbed forest?
5. Describe the regions of the Amazon Basin where you would be most likely to see evidence of deforestation.

Checklist

I have:

- presented the information neatly
- drawn in pencil
- coloured/shaded with a key/legend
- accurately shown a feature or features
- included BOLTSS.

Skills questions

1. Précis maps are used to show information that is:
   a. detailed
   b. unseen
   c. simplified
   d. complex.
2. A précis map includes information about:
   a. numbers of features
   b. location of a feature
   c. size of a feature
   d. weight of a feature.
3. Why are précis maps a useful tool for geographers?
4. What information can you get from looking at a précis map?

6.14 Review

6.14.1 Review

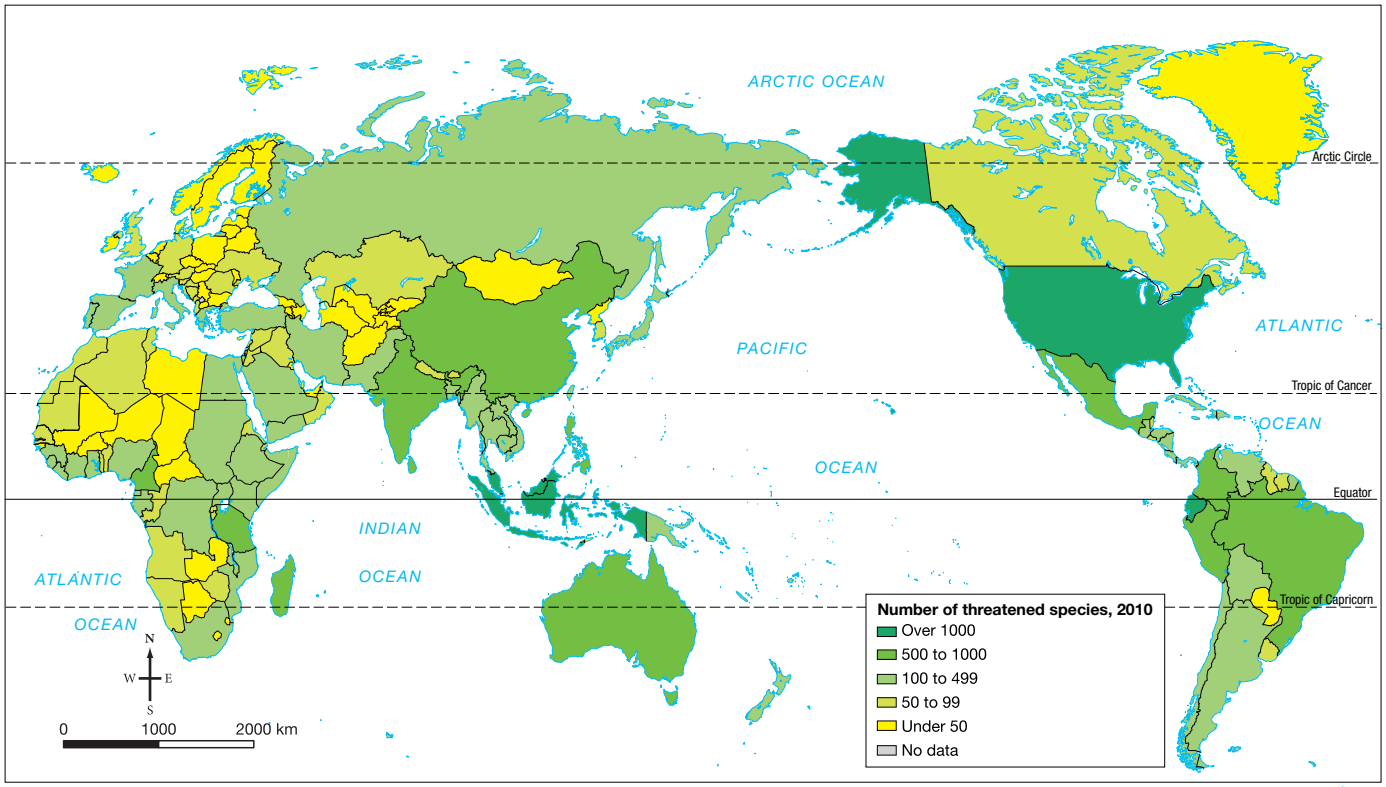
1. Copy and complete table 1.

TABLE 1 Features of rainforests around the world

Type of rainforest	Description	Location	Plants and animals found
Lowland tropical rainforest			
	Smaller trees, often covered in fog and mist		
			Giant panda, Tasmanian devil, wolves

2. Cattle ranchers believe that the ground on which a tropical rainforest grows is more valuable than the forest itself. Do you agree or disagree with this point of view? Justify your answer.
3. One hundred million years ago, Australia was covered in rainforest. Where are our forests concentrated now? Why has this ***changed***?
4. What are some of the ways in which a rainforest is valuable even if it is left alone?
5. A saying of the Penan tribe of Borneo is that 'every time a tree falls in the forest, a star falls from the sky'. Research the way of life of the Penan people. Explain why they feel this way about rainforests and how difficult it would be for them to live outside their rainforest home.
6. Explain how roads that are built into a rainforest can result in the destruction of that rainforest. You could use a series of sketches (like a comic strip) to answer this question.
7. Create a descriptive paragraph using the following question as a starting point: Why is it important for people to help conserve rainforests?
8. What might the possible consequences be on the rainforest ***environment*** and people if the trees are removed?
9. In this chapter, we have seen that there is often conflict between communities about the way to use the natural ***environment*** in rainforests. Rainforests are a very valuable resource, but different people view them in different ways.
   a. With one or more people in your class, brainstorm the ways in which rainforests are valuable to people. Try to come up with at least ten uses.
   b. Divide each of these rainforest uses into ***sustainable*** and ***unsustainable***. List the reasons why it is ***sustainable*** or not next to each type of land use.
   c. Select two ***unsustainable*** uses and then present a short report on how these uses could be managed so that they are sustainable.
   d. Which community groups might be affected by your management decisions?
   e. How would you attempt to solve any conflict that developed?
10. Write five multiple-choice questions based on material in this chapter. Your teacher can then use them for a rainforest trivia quiz.
11. Refer to figure 1 in this section and figures 4 and 5 in subtopic 6.11. What conclusions can you draw about the ***interconnection*** between the distribution of rainforests and the distribution of endangered species? Why might these patterns occur?

FIGURE 1 Distribution of endangered species



Source: Spatial Vision

6.14.2 Reflect

12. Protest songs can make people think about environmental issues. Use the **Big Yellow Taxi** weblink in your eBookPLUS to read the lyrics of one of the most famous protest songs. Re-read subtopic 6.10 in this chapter and use the information to write another verse of *Big Yellow Taxi* explaining why the forests are being destroyed.
13. Look carefully at figure 2.
    a. Describe this scene from the points of view of two of the following people.
    - A logger
    - A native rainforest-dweller
    - A conservationist

    b. Which of these points of view is closest to your own?
    c. What do you think will happen to the world's remaining rainforests over the next 20 years?
    d. What do you think should happen to the world's remaining rainforests over the next 20 years?

FIGURE 2 Devastation left by logging in a rainforest



CHAPTER 7

Fieldwork inquiry: How does a waterway change from source to sea?

7.1 Overview

7.1.1 Scenario and task

Task: Produce a report and presentation about the way in which your local catchment changes from the upper to the lower reaches.

Everybody lives in a catchment and its health is influenced by the activities in all areas within it. Your local water authority has received contradictory reports about the current state and health of your local catchment. As the reports are contradictory and the local water authority is not sure which is valid and which is not, they need to undertake a detailed study of the natural and built environments in the local catchment area. This will put them in an expert position to question and quash statements made by non-experts.

Your task

Your team has been commissioned by the local water authority to compile and present a report evaluating the current state of your local catchment. Your team must gather data to investigate how the catchment changes from the upper to the lower reaches. Your investigations will cover river characteristics such as depth, width and other channel characteristics, the fauna and flora in the area, and the land use in the catchment. In order to ensure that your report is accurate, your team can gather data about a local waterway and its immediate catchment by observing, collecting, interpreting and presenting your findings.



7.2 Inquiry process

7.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You can complete this project individually or invite members of your class to form a group. Save your settings and the project will be launched.

- **Planning:** Navigate to your Research Forum. You will need to research the characteristics of your local catchment area. In order to complete sufficient research, you will need to visit a number of sites within the catchment, comparing different locations upstream and downstream of one creek or river. Research topics have been loaded in the system to provide a framework for your research:
  - **What** sort of data and information will you need to collect at your fieldwork sites?
  - **How** will you collect and record this information?
  - **Where** would be the best locations to obtain data? You can determine this once you know which waterway(s) you are visiting.
  - **How** will you record the information you are collecting? Consider using GPS, video recorders, cameras and mobile devices (laptop computer, tablet, mobile phone).

Before going out into the field, examine topographic maps and aerial photos or satellite images of the relevant area to identify key landmarks (such as the location of your school, and the location of the waterway relative to the school). Locate the catchment boundary, the path of the waterway and the watercourse it contributes to. Construct a sketch map of the waterway — this map should show the catchment boundary/watershed, the river channel and the direction in which the water is flowing. Clearly note compass directions on the map. Gather spatial (mapped data) information about the region (using, for example, street directories, topographic maps, aerial photos and satellite images from sources such as Google Earth) and information about planning, population, land use, and flora and fauna. Refer to your Media Centre for potential sources of information.

Discuss with your group what you might already know about your catchment and then divide the research tasks between you. Discuss the information you will be looking for and where you might find it. Choose land use categories that you will be able to recognise and a mapping symbol to be used for each. The weblinks in your Media Centre will help you get started. You can view and comment on other group members' articles and rate the information they have entered.

7.2.2 Collecting and recording data

Depending on the catchment you visit, you could investigate some or all of the following:

- channel depth at various points across the stream
- channel width or cross-section
- stream flow velocity (how fast the water is flowing)
- flora transects
- fauna surveys
- land-use surveys.

Other relevant observations may include:

- condition of the waterway banks
- native and exotic vegetation
- cleared land
- evidence of erosion
- land-use zones
- potential pollution sources (including stormwater drains entering the waterway and sewage overflow points)
- building sites, industrial and residential areas
- pollution control devices
- erosion control.

Ensure that you take relevant measuring equipment into the field, and that several measurements are taken at each site. It is useful to divide tasks among groups and then share data when you are back at school. Use a copy of your map to record the information at each site.

7.2.3 Processing and analysing your information and data

Once you have collected, collated and shared your data, you will need to decide what information to include in your report and the most appropriate way to show your findings. If using spreadsheet data, make total and percentage calculations. Some measurements are best presented in a table, others in graphs or on maps. If you have used a spreadsheet, you may like to produce your graphs electronically. Use photographs as map annotations (either scanned and attached to your electronic map or attached to your hand-drawn map) to show features recorded at each site. You may also like to annotate each photograph to show the geographical features you observed. Describing and interpreting your data is important.

Visit your Media Centre and download the report template and the presentation planning template to help you complete this project. Your Media Centre also includes images, videos and audio files to help bring your presentation to life. Use the report template to create your report. Use the presentation template to create an engaging presentation that showcases all of your important findings.



7.2.4 Communicating your findings

You will now produce a fieldwork report and presentation of your findings. Your report should include all of the research that you completed and all evidence to support your findings. Ensure that your report includes a title, an aim, a hypothesis (what you think you will find, which is written before you go into the field), your findings and a conclusion. You will also need to recommend some type of action that needs to be taken to improve river management at the creek or river you visited.

7.3 Review

7.3.1 Reflecting on your work

Think back over how well you worked with your group on the various tasks for this inquiry. Determine strengths and weaknesses and recommend changes you would make if you were to repeat the exercise. Identify one area where you were pleased with your performance, and an area where you would like to improve. Write two sentences outlining how you might be able to do this.

Print out your Research Report from ProjectsPLUS and hand it in with your fieldwork report and presentation, and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

Suggested software

- ProjectsPLUS
- Microsoft Word or any other word processing tool
- PowerPoint or any other presentation tool

Media Centre

Your Media Centre contains:

- fieldwork data recording templates
- a report template
- a presentation template
- a selection of images and audio and video files to add richness to your presentation
- weblinks to sites to assist in your catchment research and to provide sample presentations
- an assessment rubric.





Many people like to travel to beaches like this popular one in Scheveningen, Holland, or to overseas cities, to experience differences other places offer

TOPIC 2

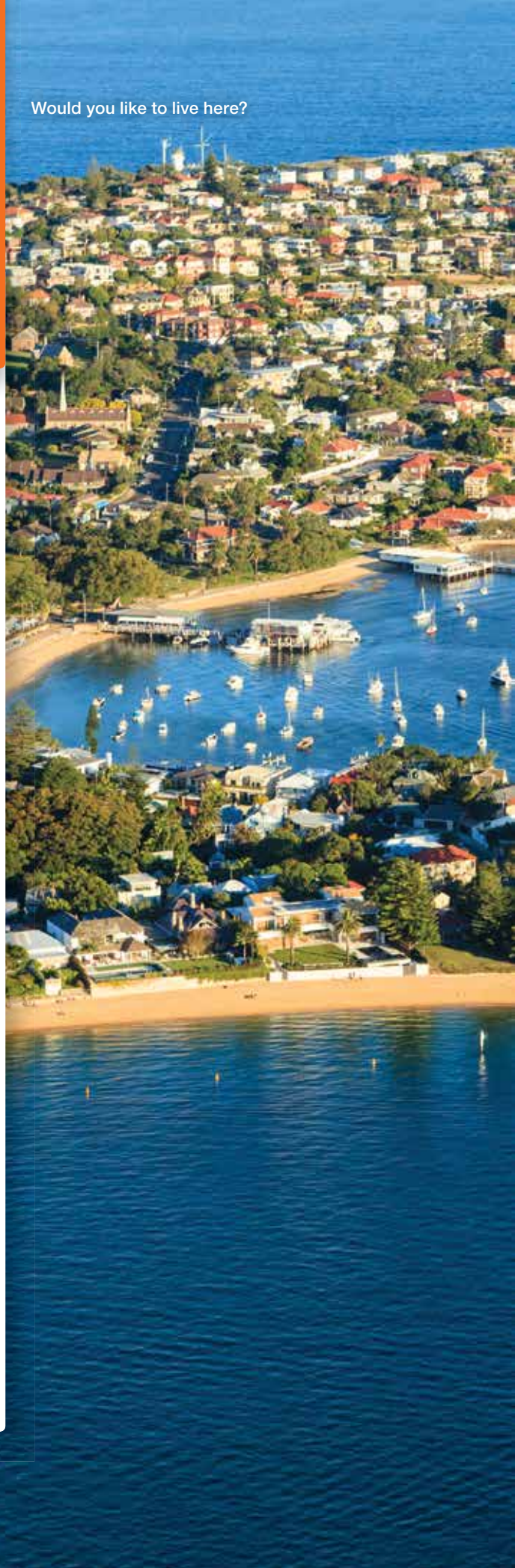
PLACE AND LIVEABILITY

Have you ever stopped to consider why you live where you do? What prompted your family to live there? Whether rural or urban, coastal or inland, small or large, different places are more 'liveable' for some people than for others. The question arises, how can the places in which we live contribute to people's wellbeing?

KEY INQUIRY QUESTIONS

- Why do people's perceptions of the liveability of places vary?
- What effects do environmental quality and access to services have on people's wellbeing?
- How can strong community identity and social connectedness enhance the liveability of places?
- What approaches can be used to improve the liveability of places?


SHENZHEN
CHICAGO
TEHRAN
Mahila
NEWYORK
Shenzheh
Lagos
ISTANBUL
Jakarta
SaoPaulo
KARACHI
DELHI
Beijing
TOKYO
LIMA
LosAngeles
London
BOGOTA
KOLKATA
Seoul
CAIRO
DELHI
TOKYO
SHANGHAI
&Co



Would you like to live here?

CHAPTER 8

Where do Australians live?

8.1 Overview

8.1.1 Introduction

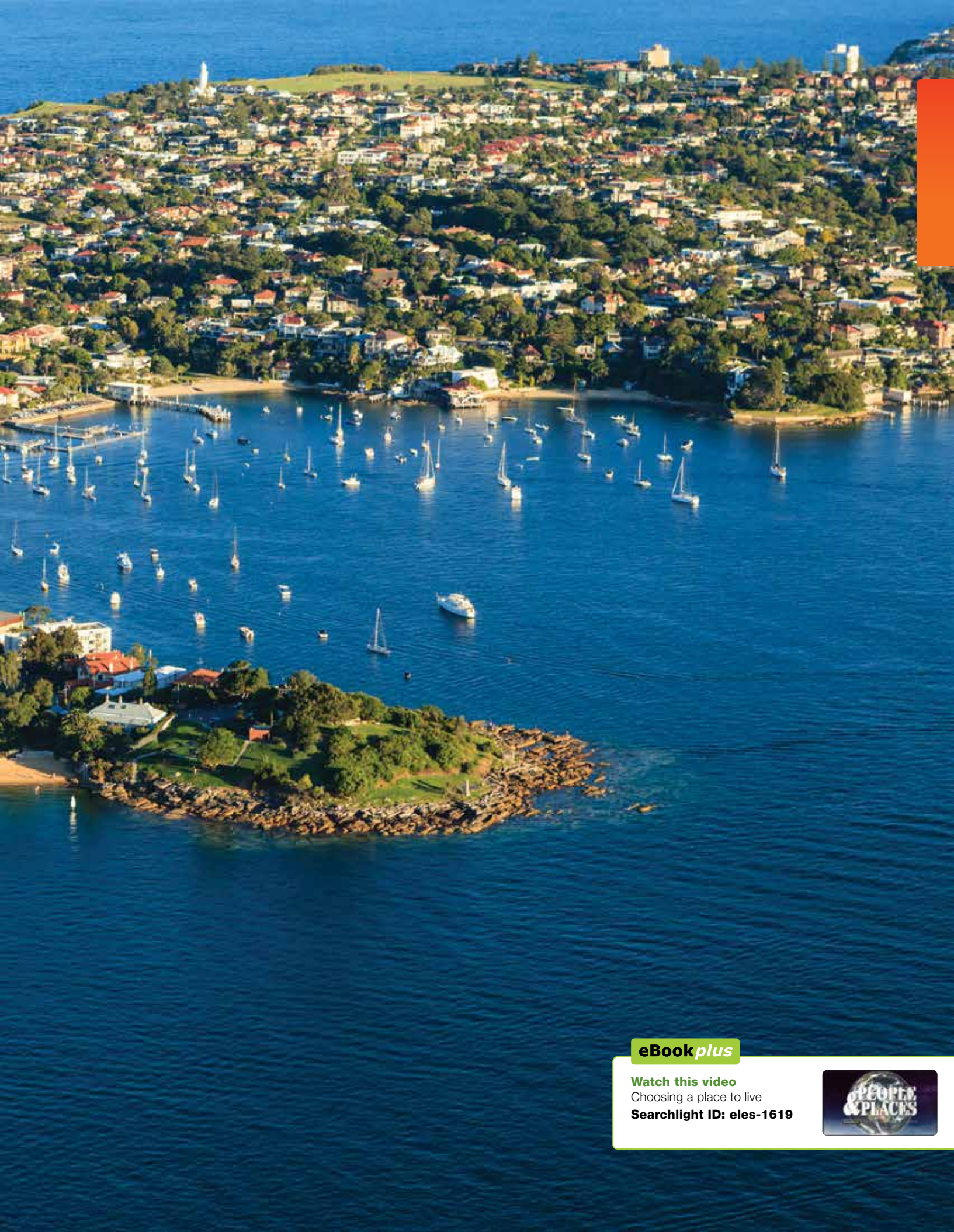
Why does your family live in the place, state, city, street or house that it does? Why do many Australians live in big cities near the coast? Have you thought about the reasons why your parents selected the place or environment in which you now live? People living in Australia have been making choices about where to live for many thousands of years. What factors have influenced the decisions made? Do people choose to live in places they feel are the most liveable? Let's try to work out why Australians choose to live in the places they do.

Starter questions

1. If you could live anywhere in the world, where would it be and why?
2. If your answer to question 1 is not in Australia, which part of Australia do you think is the most similar to the ***place*** you chose?
3. What are the geographic features of the place you would ideally like to live in? Geographic features can usually be mapped, and include climate, landscape, ***environment*** (either built or natural), jobs, culture, infrastructure, wealth and safety. Find an image of this ***place*** and annotate its geographic features.
4. Look at the image on this page. List the positive and negative aspects of living in this ***place***.

Inquiry sequence

		Syllabus outcomes
8.1 Overview		
8.2 What creates a sense of place?		GE4-1
8.3 Why do people live in certain places?		GE4-3, GE4-4
8.4 Where do you live and why?		GE4-3, GE4-4
8.5 SkillBuilder: Interpreting population profiles	eBookplus ONLINE ONLY	GE4-7
8.6 Why do Australians live in remote places?		GE4-4
8.7 What draws people to rural areas?		GE4-1, GE4-3, GE4-4
8.8 Investigating topographic maps: What draws people to Griffith?		GE4-1, GE4-3, GE4-4
8.9 Are rural communities sustainable?	eBookplus ONLINE ONLY	GE4-1, GE4-3, GE4-4
8.10 What are 'lifestyle' places?		GE4-4
8.11 Where is my place?		GE4-4
8.12 SkillBuilder: Constructing a basic sketch map	eBookplus ONLINE ONLY	GE4-7
8.13 Where would you like to live?		GE4-4
8.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Choosing a place to live
Searchlight ID: eles-1619

8.2 What creates a sense of place?

8.2.1 A sense of place

Places are central to the study of geography. This is because geographers are interested in where things are found on Earth and why they are there. But what exactly is a place?

place specific part of the Earth's surface that has been identified and given meaning by people

location where a point on the Earth's surface is to be found

region any area of varying size that has one or more characteristics in common

To understand what a place is, think about **location** and **region**. Each place has a unique identity that makes it different from other places. A combination of characteristics is specific to that place, making it individual. A sense of place comes from being aware of what makes that location significant and seeing its special qualities.

These may include:

- natural features, such as a harbour or natural spring
- human features — that is, built by people
- a combination of natural and human features.

Eventually, one or more of these features becomes a symbol of that place in people's minds; figure 9 is an example of this.

FIGURE 1 Greece — coastal settlement on the island of Santorini



FIGURE 2 Iceland — Northern Lights



FIGURE 3 Greece — Meteora of Kalampaka





FIGURE 4 Spain — a market place



FIGURE 5 Brazil — City of Rio de Janeiro



FIGURE 6 Hawaii — tropical reef snorkelling



FIGURE 7 India — the Taj Mahal in Agra



FIGURE 8 Morocco — desert landscape



FIGURE 9 Turkey — Anzac Cove

GEOskills TOOLBOX

Political maps

Figure 10 is a political map showing human features such as:

- the boundaries of countries
- capital cities
- major water bodies.

Political maps may also show state boundaries. Colour and labelling are used to clearly show neighbouring countries, and their comparative sizes. A political map often shows the capital city of each nation.

FIGURE 10 Political map of North and Central America



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1. Study figures 1 to 9. Choose five of the images shown and list the special features about each ***place***. Consider natural as well as human features.
2. Refer to your answers to question 1. What was the most common feature in your responses?
3. Suggest reasons why these ***places*** have become famous around the world.

EXPLAIN

4. Conduct a survey of your class to find out each person's top five favourite ***places*** to visit in Australia or NSW. Collate the results in a table like the one below.

Place	Student A	Student B	Student C
Great Barrier Reef	✔		✔
Uluru		✔	✔
My grandparents' farm near Ballina, NSW		✔	

This table could also be set up electronically, using a spreadsheet program.

5 Graph the results to show the ranking of the ***places*** by percentage of the class; for example, 45 per cent of the class named Uluru in their top five ***places*** in Australia.

6 As a class, discuss the patterns shown by the graph. Suggest reasons to explain why people like or dislike certain ***places***.

INVESTIGATE

7 Why do you think people consider a ***place*** to be special? What makes people prefer one ***place*** over another ***place***? Ask two to three people these two questions, and record their responses in your workbook.

8 No matter where we live, we all live in the one ***place***: Planet Earth. A place is given meaning by people. Introduce a ***place*** that has special meaning to you. Where is it? What special feelings do you have when you are there? Include an image and annotate the natural (green arrows) and the human (blue arrows) features of the ***place***.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › New York

8.3 Why do people live in certain places?

8.3.1 Changes over time

People choose to live in specific places for a wide range of reasons. These reasons can be broadly divided into **pull factors** and **push factors**. The combination of reasons varies from person to person, and what is an advantage for one person may be seen as a negative by someone else.

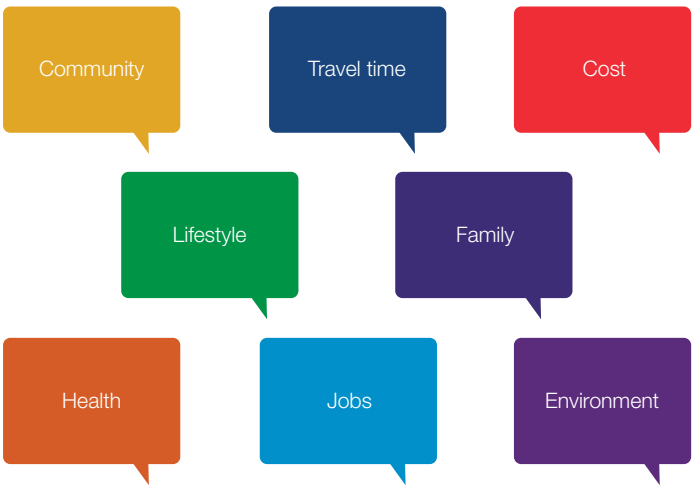
It is also true, though, that the reasons people choose to live in a place may change over time. 'Liveability' refers to what a place is like to live in. Over time, places change.

pull factors positive aspects of a place; reasons that attract people to come and live in a place

push factors reasons that encourage people to leave a place and go somewhere else

Some of the factors that influence the liveability of a place are shown in the figure below.

FIGURE 1 Factors that may influence where we choose to live

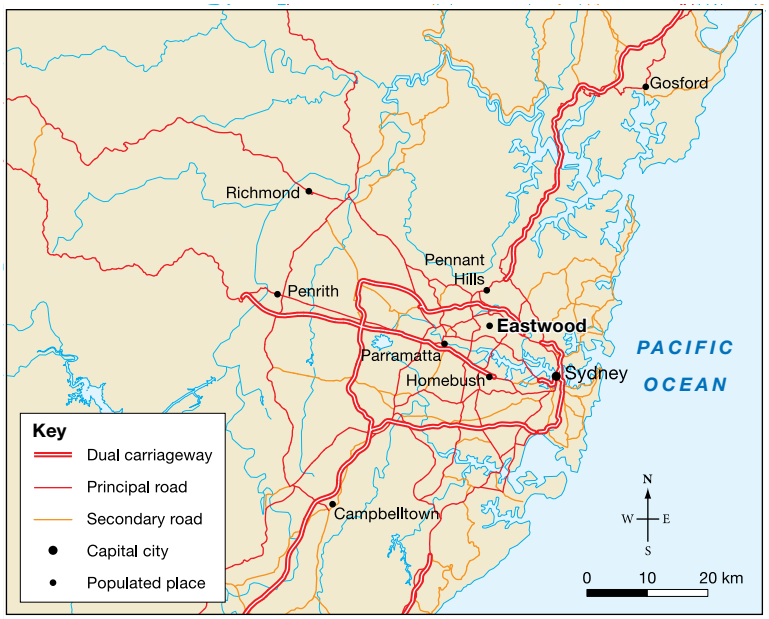


Many of these factors change throughout a person's life. For example, where a 20-year-old single person wants to live is often quite different from where someone in their forties, or someone with a partner and two teenage children, may want to live.

Eastwood is a Sydney suburb located 17 kilometres north-west of the Central Business District.

It is marked on the map of Sydney (figure 2). This map shows more of the area of Sydney, with little detail of what the suburb of Eastwood actually looks like.

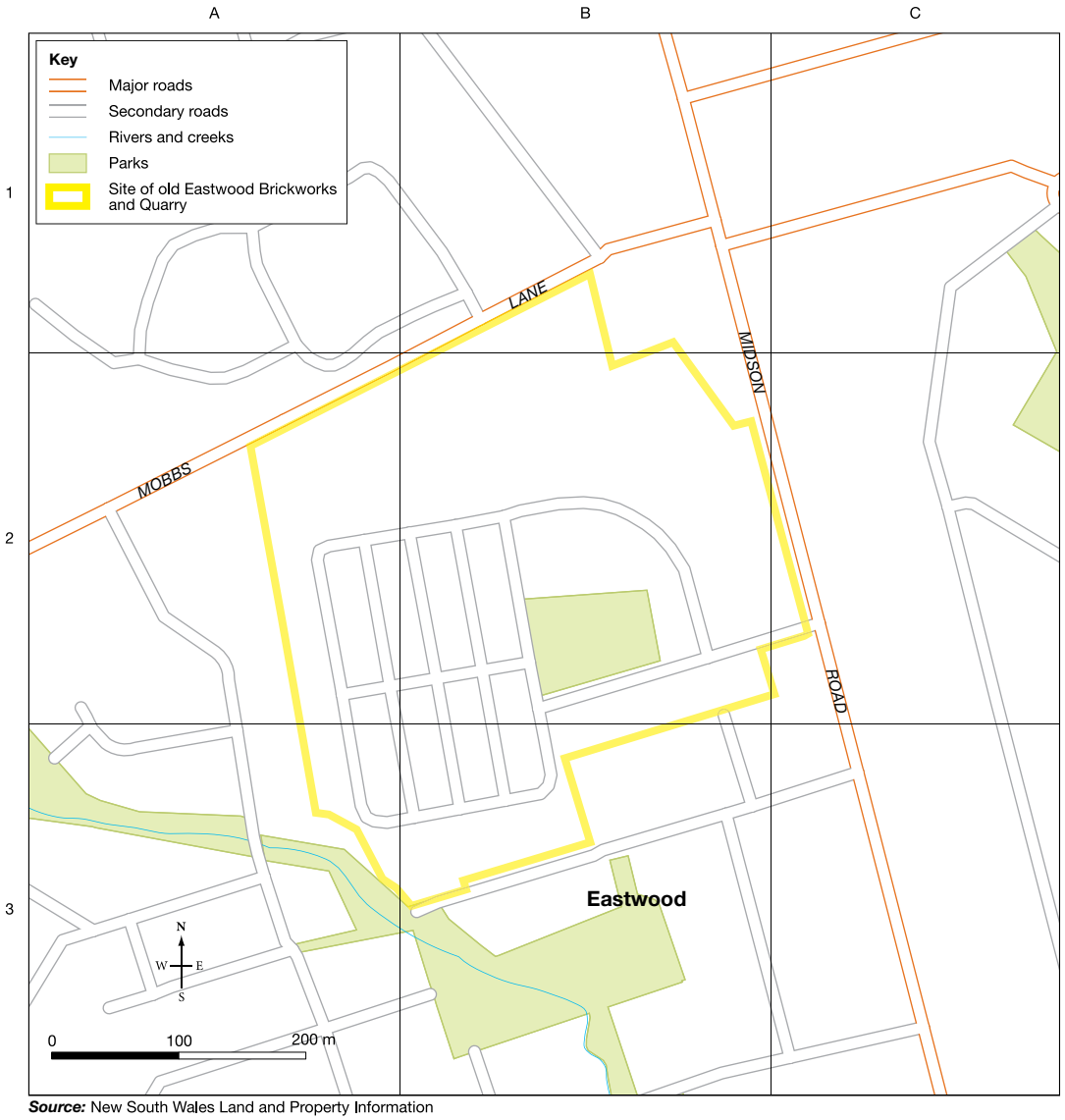
FIGURE 2
Map of Sydney showing the location of Eastwood



Source: Geoscience Australia

From 1913 until 2003, the Eastwood Brickworks operated at a site located at the corner of Midson Road and Mobbs Lane. This site is shown in figure 3.

FIGURE 3
A map showing the Eastwood Brickworks site



Source: New South Wales Land and Property Information

This map shows basic detail such as names of major roads, creeks and parks of the suburb of Eastwood. Figure 3, compared to figure 2, is said to have a larger scale: that is, it shows a larger amount of detail of a smaller area of land.

The Brickworks site contained a quarry, brick-making facilities, three brick kilns and two chimneys (figure 4). Bricks were in great demand for building as Sydney suburbs grew. Up to 35 000 bricks were made per day. Residents living near the site reported hearing blasting from the quarry and seeing dust in the air. The Eastwood Brickworks were an important source of jobs during its operation.

FIGURE 4 The former site of the Eastwood Brickworks (2009)

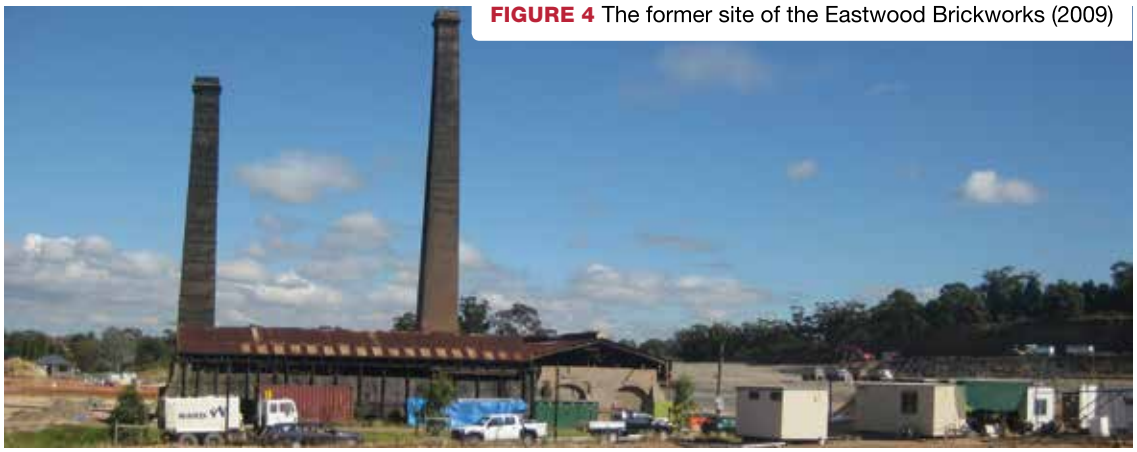


FIGURE 5 An artist's drawing of Eastwood Brickworks site (2003)

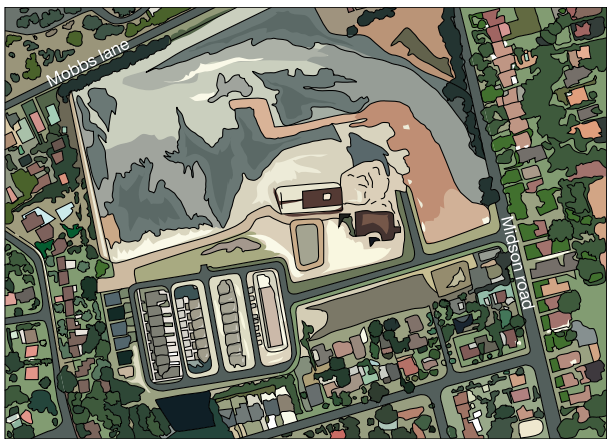


FIGURE 6 The former industrial site has been transformed into a residential zone (2009).



FIGURE 7 Aerial view of Eastwood residential estate (2015)



FIGURE 8 New housing has been built above the former brick kilns.



ACTIVITIES

IDENTIFY

1 Refer to figure 1. Imagine you have been asked to prepare a sign to highlight the positive features of the area in which you live. What factors would you promote about your suburb or town?
2 What impact would the industry at Eastwood have had on neighbouring residents of this industrial site?
3 Identify the push and pull factors for residents of Eastwood living beside the brickworks when it was an industrial site?

EXPLAIN

4 Refer to figure 3 and figures 5 and 7. Suggest a reason for the rounded shape of the housing estate at the north-east corner.
5 Suggest reasons why people would continue to live in an area that is changing around them.

APPLY

6 Present the answers using a column graph, correctly and fully labelled (see SkillBuilder 15.6 'Creating a simple column or bar graph').
7 As a class, discuss the pattern of reasons shown by the graph, and the possible explanations for this. For example, how important to people are social connections?

INVESTIGATE

8 Use Google Earth to find your town or suburb.
   a Use the historical imagery icon to display the range of images available for your location.
   b Move the slider along the timeline to show aerial views of changes to a place.
   c Select two times along the timeline to screen clip an image.
   d Annotate the changes that have occurred to the environment.
9 Suggest future changes to your suburb or town? What impact do you think this might have on the positive factors you identified in question 1?

eBook*plus*

Interactivity
Push/pull factors
Use this interactivity to see how many factors you can correctly classify as either push or pull factors.
Searchlight ID: int-3089

FOCUS ON FIELDWORK

Investigating why a place is special

Using the tips in SkillBuilder 20.11 'Using advanced survey techniques — interviews', create a survey designed to explore the reasons for moving to or from a place or an environment. Why do you think people live where they do?

Surveys can be distributed digitally or face to face. Perhaps your questions may ask about the length of time lived at the current address and reasons for moving. Classify the responses using the four categories identified below in a table similar to the following example.

Student	Resources	Employment	Relationships	Lifestyle
Gina	Near major shops	Near my dad's work		
Miguel		Near my mum's work	Close to my family who came to Australia earlier Close to my father's best friend	
Daniel				Near the sea, as we all sail or surf

8.4 Where do you live and why?

8.4.1 How did I get here?

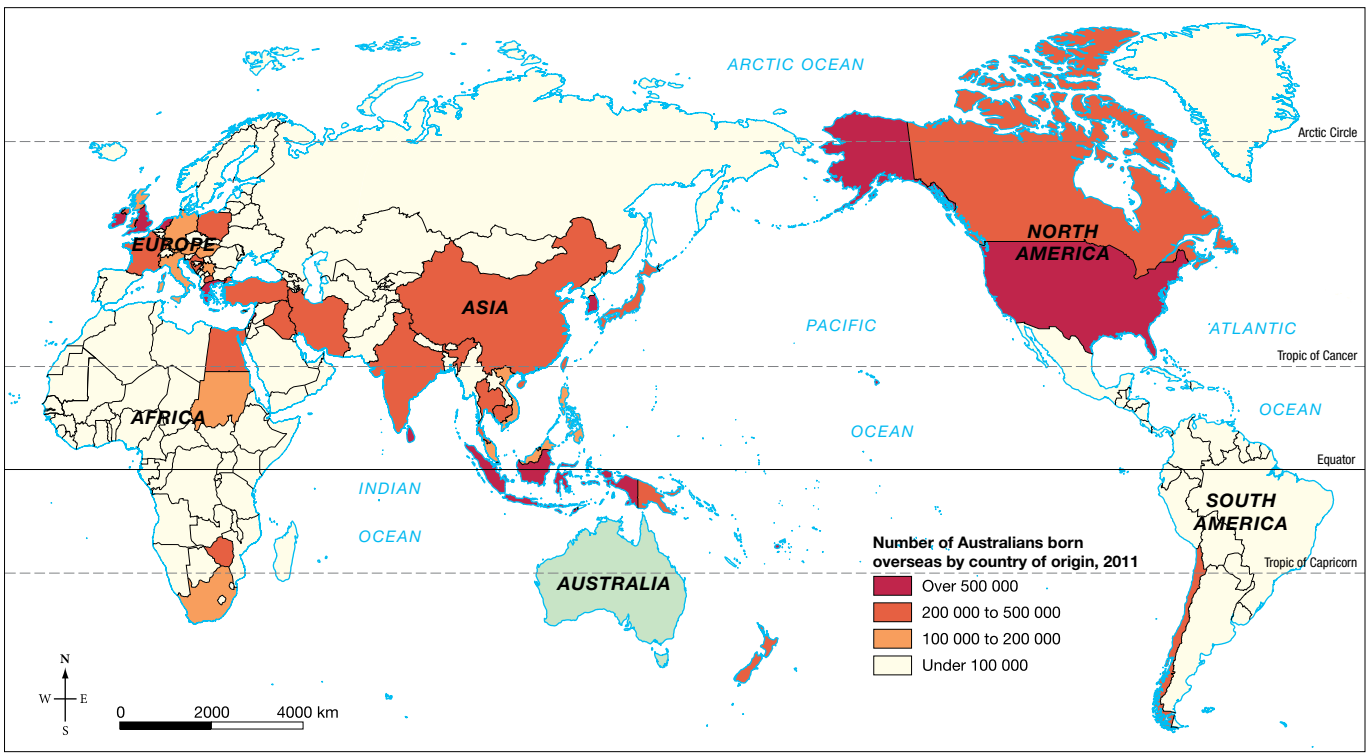
When we first learned to write our address, we often included our house number, street, town, city, state, country, continent, hemisphere, planet and universe. You could also identify your location with GPS coordinates, a grid reference or by use of latitude and longitude. Knowing the place where you are is important but so is how you got there.

Have you always lived where you are currently living, or did your family arrive from another place? What decisions were made by your parents or grandparents, which resulted in your family living in your place, house, state, country or hemisphere? Over 28 per cent of Australia's population were born overseas, and it is estimated that most will move homes between 11 and 12 times during their lifetime.

What is your story?

Activity 1 allows you to investigate the place where you live. It is a task of discovery, and will take you some time to complete. Your aim is to discover your family's migration story and why you live where you do. Does your family have a recent migration story or did your family arrive with the First Fleet? Do you have Aboriginal or Torres Strait Islander heritage? Did your grandfather build the house you live in or did your parents or carers build your house? How has the place your family lives in changed over time and space? Many Australians living here today, such as the people in figure 2 below, were not born here. In fact, in mid 2015, over a quarter of Australia's estimated resident population were born overseas. Figure 1 shows us that many Australians were born in the United Kingdom, New Zealand, and the United States of America.

FIGURE 1 Australians born overseas



Source: Spatial Vision

FIGURE 2 The story of four Australians who were born overseas



Cindy: When I lived in Bejing I was called Jing-Wei. I came to Sydney in 1988 to study economics at university. I became an Australian citizen in 1993. I now have three Australian children.



Andrew: I came to Perth with my wife and three children in 1993 just before Nelson Mandela was elected president of South Africa. We were concerned for our safety in Johannesburg and were keen to start a new life in a country with a similar climate and language. Now two of my brothers also live in Australia.



Lucy: My brother moved from Palmerston North in New Zealand to Melbourne for work in 2006 and I followed him the next year. I like living in a larger city. There is more going on and I get paid a lot more. One day I might return to New Zealand.



Deepak: My family moved from Delhi in 1988 when my father was offered a job in a computer company in Adelaide. There were not many Indian kids in my school but I studied hard and went to university. I now have three children and live in Newcastle.

ACTIVITIES

INVESTIGATE

1 This task allows you to discover your family's migration story and why you live where you do.

Step 1

What can you find out for yourself?

Your place

- What is your address? Write out your full address, including your hemisphere, latitude and longitude.
- Use Google Maps to locate and identify your house in your street. Download an **aerial view** and a **street view** of your house.
- Annotate your aerial photo or map to identify who lives in your house, including pets, and which parts of the house they use. You could illustrate the people who live in your house in a cartoon — like the stickers, or decals, of families that people put on their cars.
- Ensure that your map has a compass, approximate ***scale*** and appropriate title.

Step 2

Your neighbourhood

- Using Google Maps, download an aerial view of your street or at least the eight closest houses or dwellings.

Step 3

How long have you lived at this address?

If you have previously lived somewhere else, list and map your past addresses. How many times have you moved? Share with your class the information that you have collected so far.

Step 4

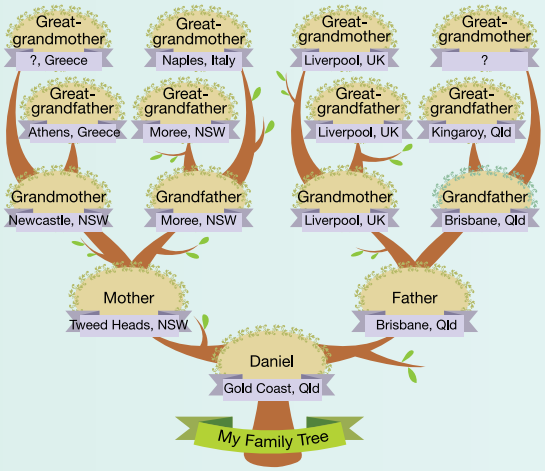
How did you get here?

To investigate the rest of your story, you will need to speak to your parents and possibly your grandparents. As you collect information about where your parents and grandparents were born, create a family tree of ***places***. Try to find out why and when your relatives came to Australia. Figure 3 illustrates how this may look.

- Where were your parents/carers born?
- Why did your parents move to where you now live?
- Why did your grandparents and great-grandparents move from their ***place*** of birth?

Use the **Family tree template** weblink in your eBookPLUS to create your family tree.

FIGURE 3 An example of what your family tree may look like



APPLY

2 Use your family tree, to create a map that shows this ***interconnection***.

Things to think about before starting your map:

- What ***scale*** and size of map will you need?
- Would you be better off having two maps? In the figure 3 example, Daniel's parents

aerial view an image taken from above an object; also known as a bird's-eye view

street view an image of a building taken from the road or footpath, at street level

eBookplus

Weblink
Family tree template

FIGURE 4 Immigrants arriving in Australia by plane, 1967



and grandparents mostly came from New South Wales and Queensland but most of his great-grandparents came from Europe. To map this information, he should use a world map plus a larger ***scale*** break-out or inset map of New South Wales and Queensland.

- Draw an arrow to indicate the movement between the two ***places***.
- What is an appropriate title for your map?
- Would you like to illustrate your map with images of your relatives, their houses, flags of the countries they came from or images of the transport that they used? If you wish to add images, you will need to have a larger ***scale*** base map than if you just used symbols.
- You could annotate the map with the reasons your relatives moved.

GEOskills TOOLBOX

Population profiles

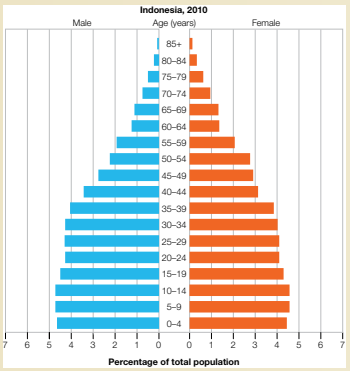
A place will reflect the characteristics of the people who choose to locate there. Populations bring special qualities to a location and shape the type of community that develops. A population profile is based on Census data and it details factors such as age, gender, ethnicity, education and working characteristics. Population profiles for your local area provide clues about people living in your town or suburb.

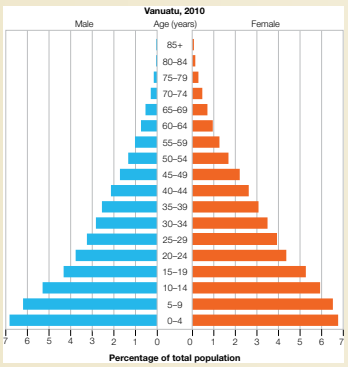
eBook*plus* ONLINE ONLY

8.5 SkillBuilder: Interpreting population profiles

What is a population profile?

A population profile, sometimes called a population pyramid, is a bar graph that provides information about the age and gender of a population. The shape of the population profile tells us about a particular population. Comparing population pyramids of different places helps us try to understand how and why they may be similar or different.





eLesson

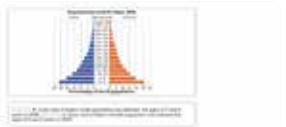
Watch this video to learn how to interpret population profiles.



Searchlight ID: eles-1704

Interactivity

Try this interactivity to learn how to interpret population profiles.



Searchlight ID: int-3284

8.6 Why do Australians live in remote places?

8.6.1 Settling inland Australia

Inland locations, away from large cities and coastal areas, are attractive places for many Australians to live. Why do some people choose to live in places where their nearest neighbour may be 50 kilometres away or a weekly sporting activity involves a six-hour car trip? Why do they find remote places more liveable?

The general shift of Australia's population for the last 100 years has been towards the major cities and away from the country (see figure 1). The average age of farmers in Australia is about 53 years, which is 13 years older than the rest of the workforce. Most children of farmers leave the country and seek education and work opportunities in large cities. There have been many attempts by governments and private industry to encourage people to settle in remote locations situated far from major centres of population. Soldier settlements and mining developments are two such schemes.

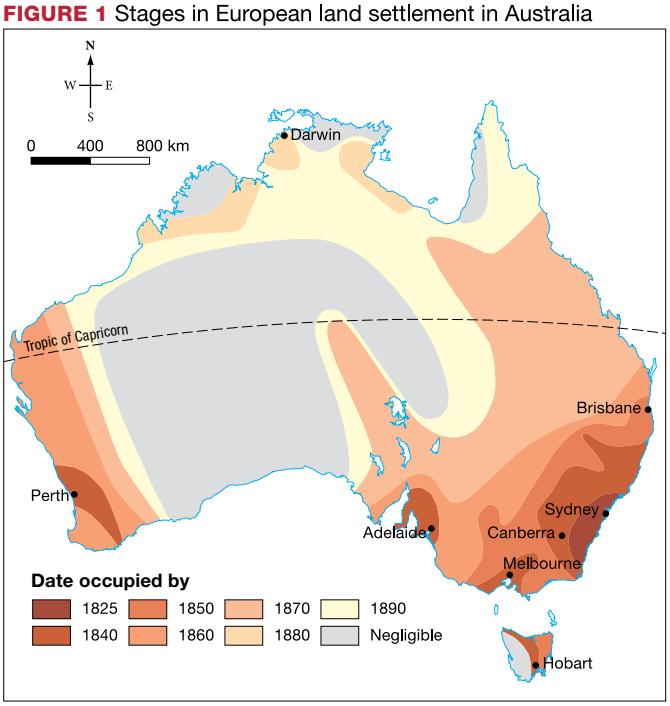
Government policy

The federal, state and local governments make decisions that shape patterns of settlement. In Western Australia, the future is uncertain for 274 Indigenous communities that rely on government funding for health, education, housing and social assistance. Remote settlements in WA are being assessed to determine what support they might need in the future; these decisions may impact where people choose to live. In New South Wales, local governments have combined to promote an Evocity project designed to attract people to regional centres.

Soldier settlement schemes

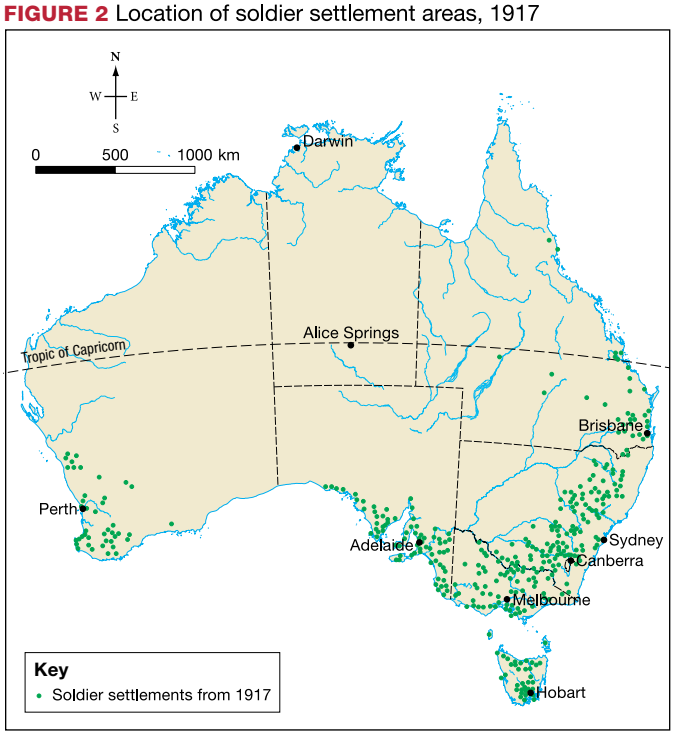
After both World War I and World War II, the state and federal governments of Australia began a program of providing land to returned soldiers (figure 2). The programs were designed to give soldiers work and to attract people to places that were sparsely inhabited at

FIGURE 1 Stages in European land settlement in Australia



Source: Spatial Vision

FIGURE 2 Location of soldier settlement areas, 1917



Source: Spatial Vision

the time, such as Griffith and Dorrigo in New South Wales (see figure 2). The settlers were expected to stay on their land for five years and to improve the quality of the land they were farming. Many farmers are descendants of these soldiers and continue to work the land. Over 25 000 soldiers were resettled after World War I.

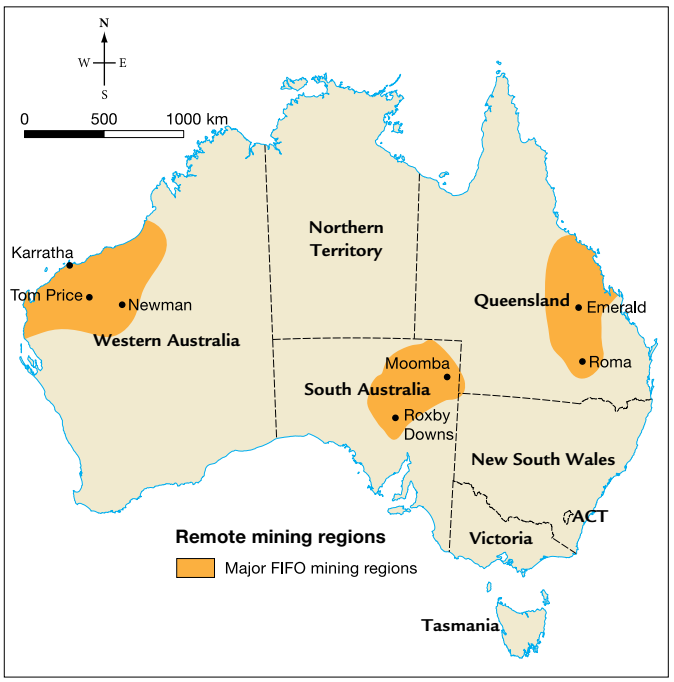
Mining developments

Mineral resources are being extracted at **remote** locations such as Broken Hill, The Pilbara and Tom Price. Workers are attracted to these areas by high wages and job opportunities. For example, a truck driver can earn $150 000 per year. Some workers **fly in and fly out (FIFO)** for their shifts. They live with their families in less remote places and fly in for a shift that may last several weeks, then flying home for their days off. Transport and communication technology enables the workers to be linked to work opportunities in isolated locations.

FIGURE 3 Soldiers returning from the war were offered opportunities to settle in remote locations.



FIGURE 4 Remote mining regions



Source: Spatial Vision

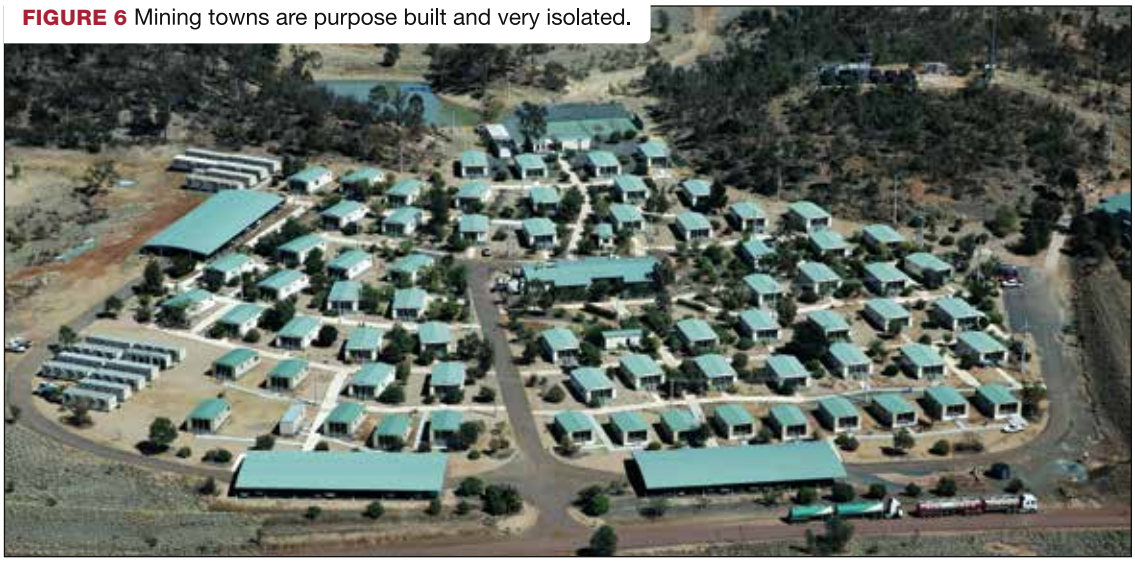
FIGURE 5 Workers travel by plane from Brisbane to Tom Price in less than 5 hours.



remote describes a place that is distant from major population centres

fly in, fly out (FIFO) describes workers who fly to work in remote places, work 4-, 8- or 12-day shifts and then fly home

FIGURE 6 Mining towns are purpose built and very isolated.



eBook*plus*

Interactivity
Remote living
Use this interactivity to explore remote areas Australians live in.
Searchlight ID: int-3090
Weblinks
- Soldier settlement
- FIFO
- Distance education

sparse thinly scattered or unevenly distributed; often used when referring to population density

ACTIVITIES

IDENTIFY

1 What makes a ***place*** remote?
2 What does FIFO stand for?
3 What challenges would **you** face living in a remote location?

EXPLAIN

4 Refer to figure 1, showing the history of Australia's settlement. Describe the ***change*** in European settlement of Australia between 1825 and 1860.
5 Refer to figure 2 and a map of Australia showing annual rainfall. Were soldier settlement areas located in ***places*** that receive good rainfall for farming?
6 Suggest reasons for the **sparse** settlement of areas targeted by the soldier settlement scheme.
7 What resources are being mined in each of the ***places*** shown in figure 4?
8 What might be an advantage to the mining companies of having FIFO workers?
9 Were any 1917 soldier settlements attempted in parts of Australia that today are remote mining regions with a FIFO workforce? Explain your answer using information from figures 2 and 4.

APPLY

10 Research one soldier settlement area using the **Soldier settlement** weblinks in your eBookPLUS. In your opinion, how successful was the scheme in populating a remote ***place***?
11 Using the **FIFO** weblink in your ebookPLUS, explore the challenges faced by communities in FIFO locations. Suggest strategies to overcome the issues being faced and to promote local employment in the current FIFO mining locations.

INVESTIGATE

12 How might people be encouraged to move from the coastal fringe to the more remote ***places*** of Australia? What could make you or your family move or relocate? Produce a short film, snappy slide show, or an advertising campaign that highlights the pull factors which might attract people to live in the more remote parts of Australia.

FOCUS ON FIELDWORK

Task

Discover why people might live in remote places.

Preparation

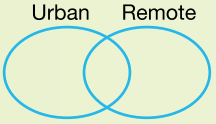
- What do you understand by *remote*?
- Consider the challenge of getting an education when you live 300 kilometres from the nearest school?
- What would you like to ask a teacher of remote students?

Fieldwork

Use the **Distance Education** weblink in your eBookPLUS to access the tourist sessions that run daily during school term. You will be able to talk with a teacher and to sit in a live session with the students.

Reflection

Prepare a Venn diagram to compare schooling in an urban place with schooling in a remote place.



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Population of Australia

8.7 What draws people to rural areas?

8.7.1 Regional relocation

Rural areas offer a change of lifestyle and opportunity to people moving away from large urban places. Regional centres offer a range of employment opportunities in primary industries such as farming, mining and forestry or in manufacturing and service industries. A 'tree change' may offer a more relaxed and affordable lifestyle.

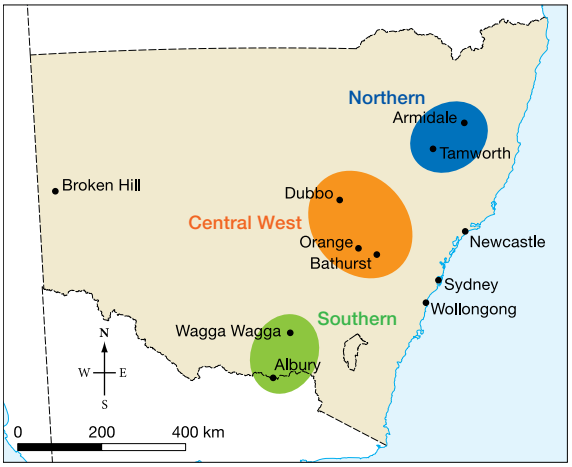
In New South Wales, capital city residents and industries are offered incentives to move to rural communities. Seven local council areas have worked together to promote Albury, Armidale, Bathurst, Dubbo, Orange, Tamworth and Wagga Wagga as centres of Energy, Vision and Opportunity; that is EVOCITIES. Residents are attracted to a cheaper lifestyle and less stressful commute to work and school (see figure 1). Industries can access larger areas of land, a local workforce and fewer water restrictions.

Well-developed internet and mobile phone technology enables new residents to maintain interconnections with family, friends and workplaces. Some people choose to move to rural locations but continue to work at their existing workplace electronically, or commute occasionally.

FIGURE 1 Tree change lifestyle opportunity



FIGURE 2 The location of Evocities in New South Wales



Source: Museums and Galleries of New South Wales.

8.7.2 Sustainable development

Evocity growth is being designed sustainably, while construction is environmentally sensitive to accommodate larger population numbers. The seven Evocity locations promote sustainable approaches to the supply of water, power and health services. Sixty-six per cent of Dubbo's growth in 2014 came from residents registered through the Evocities program.

FIGURE 3 Solar power is a renewable source of energy.



FIGURE 4 Water saving tanks for residential use



FIGURE 5 Connected and well-designed cycle ways



8.7.3 Sense of community

Most rural towns have a strong sense of community. Albury city council constructed two wood fired ovens in a centrally located, riverside park. Every second Sunday, Albury residents are invited to meet, learn, cook and share a meal together at this free activity (see figure 6) whilst Bathurst promotes a buy local campaign (figure 7).

FIGURE 6 Albury community wood fired oven

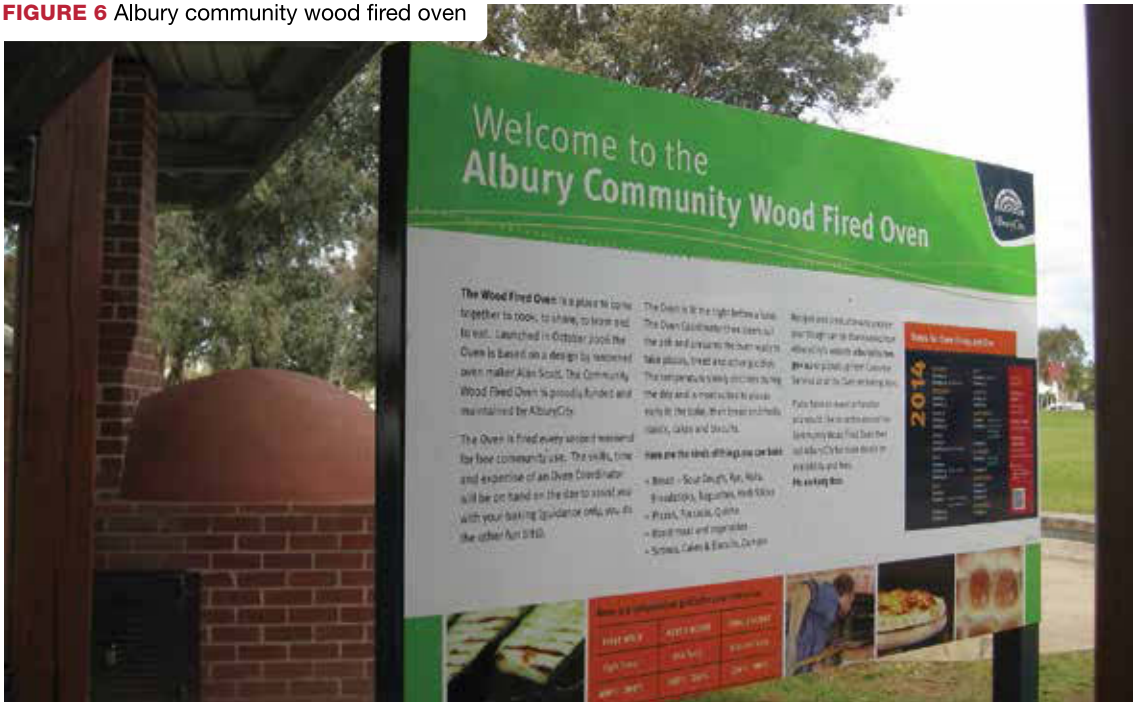


FIGURE 7 Bathurst's Buy Local campaign is designed to promote community.



ACTIVITIES

IDENTIFY

1 What is an Evocity?
2 Refer to figure 3 to name the Evocities located in New South Wales.

EXPLAIN

3 Suggest reasons for the development of Evocities in rural areas.
4 Suggest one Evocity location that would best suit your family's circumstances.
5 Suggest reasons for this choice.
6 What concerns would you have about leaving your home to settle in this ***place***?

INVESTIGATE

7 Use the internet to research the ways that new residents in your local area are welcomed into the community.

APPLY

8 Figure 1 shows people holding a cartoon demonstrating reasons to locate to an Evocity. As illustrator for a local newspaper, prepare a series of cartoons to encourage people to move away from the coastal fringe to more remote ***places*** of Australia.
9 Produce a short film, a snappy slide show, an infographic or an advertising campaign that highlights the pull factors that might attract people to live in more remote parts of Australia.

8.8 What draws people to Griffith?

8.8.1 Griffith and surrounding region

A unique sense of place exists in this rural New South Wales town. Griffith supports a growing population of more than 26 000 people, with large numbers of overseas born residents having arrived from parts of Italy and India.

FIGURE 1 Farms in the Griffith area support businesses in the town.



Around Griffith, water is directed into channels that run through the settlement and farming areas. A reliable water supply and available farmland attracted many settlers to this area after irrigation was introduced in 1912.

Griffith is located within rich farming lands of the Murrumbidgee Irrigation Area. The climate in this area is semi-arid (warm, with unreliable rainfall) and the area supports a variety of agricultural industries such as viticulture, fruit growing and rice production. The picking, processing and distribution of locally grown rural products provides employment and training opportunities for seasonal workers and the local population during harvesting periods.

ACTIVITIES

IDENTIFY

1 Using the figure 2 map key, copy the symbol for each of the following features into your notes.
   - a Orchard or vineyard
   - b Watercourse or canal (irrigation channel)
   - c Built up area

2 What land use is found at:
   - a AR 1099
   - b AR 1105?

3 What is the direction of the town of Widgelli (AR 2000) from Griffith Airport (AR 1409)?

4 What is the direction of Yenda (AR 2509) from Widgelli (AR 2000)?

5 What man-made feature is found at GR 180095?

6 What is the height of the land at GR 091084?

APPLY

7 Compare the pattern made by irrigation channels with that made by natural waterways such as Mirrool Creek. Describe your findings.

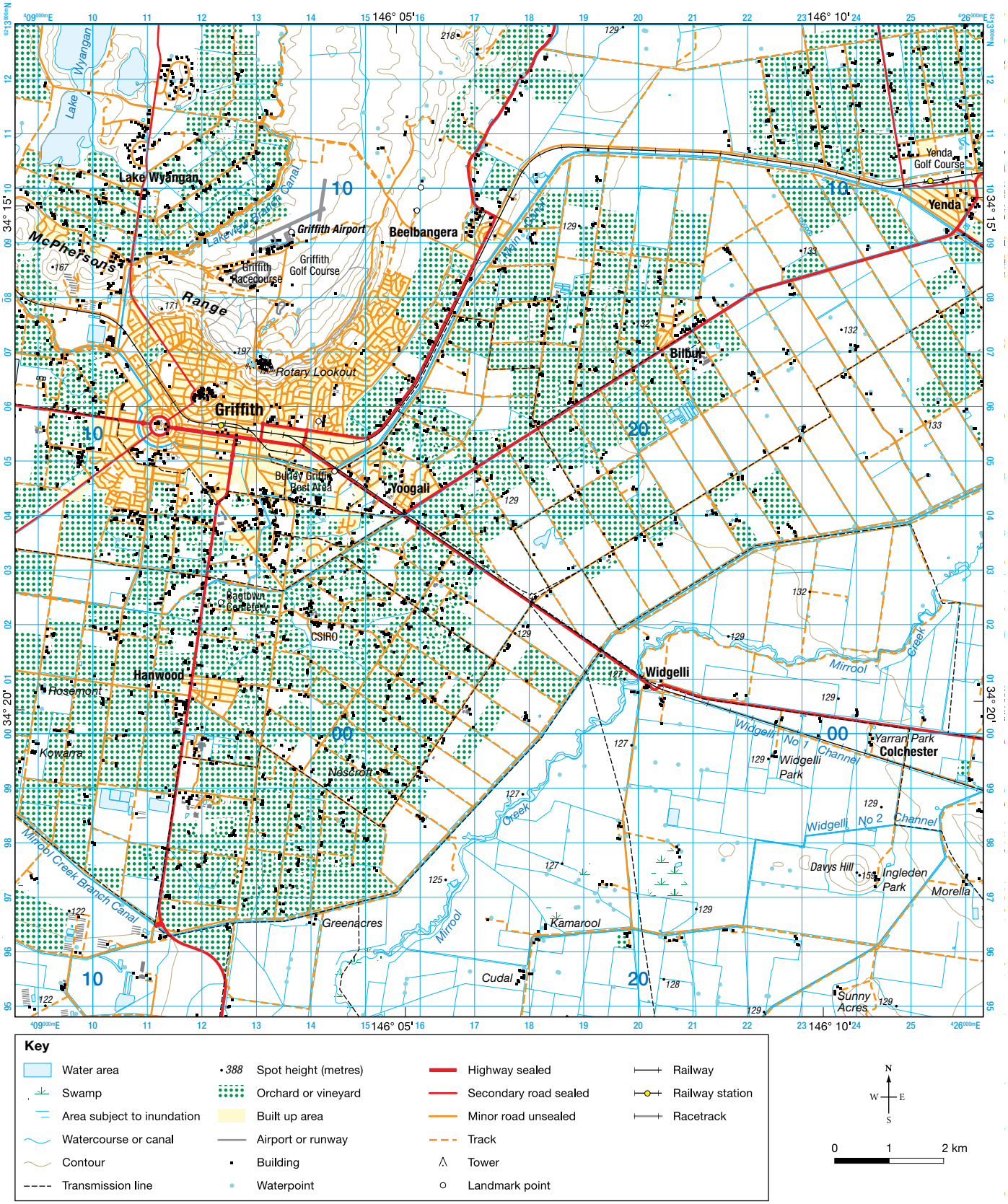
8 There are many farms in the Griffith region, which means there are many people in the area to support shops, businesses, schools and cultural activities. However, in some parts of Australia, farms are very big and it is a long way to the nearest neighbours. Anna Creek, a beef cattle property in northern South Australia, is 24 000 square kilometres (2 400 000 hectares). The property is in a semi-arid region of South Australia, where vegetation is sparse and the nearest town for supplies is 170 kilometres away.
   - a Use the scale to calculate the number of square kilometres covered by the map in figure 2.
   - b How does this compare to the single farm of Anna Creek?
   - c At which location, Anna Creek or Griffith, would you be most likely to satisfy each of the following wishes: to play in a sports team every week; to regularly buy clothes; to collect data about lizards; to grow a lush lawn; to safely learn to drive; to have a private airstrip?

eBook*plus* ONLINE ONLY

8.9 Are rural communities sustainable?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

FIGURE 2 Topographic map extract of Griffith



Source: Land and Property Information, NSW.

8.10 What are 'lifestyle' places?

sea change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small coastal town

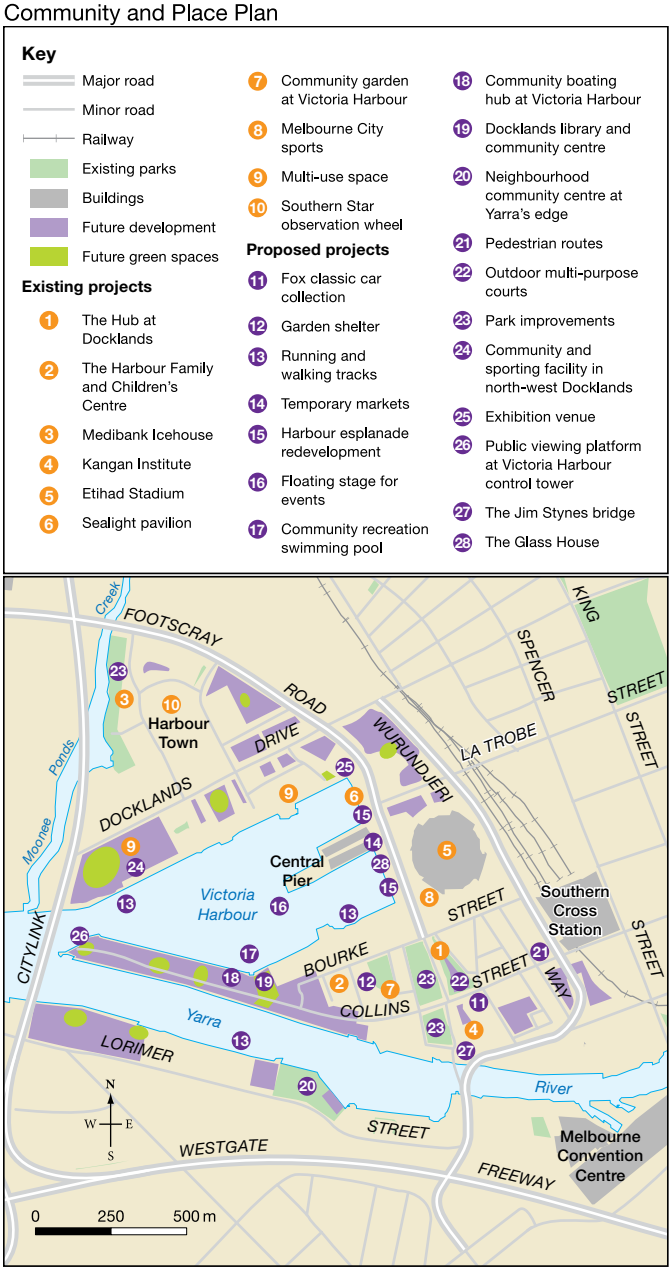
tree change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small country town, in the bush, or on the land as a farmer

8.10.1 Melbourne Docklands

A growing number of people are choosing to live in residential complexes that provide special access to shared recreational and community spaces. Many of these complexes are being built in locations that are undergoing change. During the 1990s, the healthy state of the growing Australian economy meant more people were earning higher incomes. This gave them access to a greater choice of lifestyles.

For some people, 'lifestyle choice' means escaping the rush of the modern urban society by choosing a **sea change** or **tree change**. For others, it means 'downsizing' into a smaller home, moving closer to the city centre, and its restaurants, cinemas and public transport. As a response to the large demand for this lifestyle, governments have been able to re-zone older industrial areas and to transform the land into a variety of lifestyle complexes. Such places offer the convenience of employment, residences, recreation and services all in one location. They also change older industrial areas into more vibrant communities.

FIGURE 1 The future by 2022 and beyond: Docklands Community and Place Plan



Source: Spatial Vision

Planned development and lifestyle amenities

The Docklands development in Melbourne was designed to be the face of a new-look Melbourne: a new community identity of restaurants, entertainment and apartment living (see figure 1). Docklands is a suburb of Melbourne, located two kilometres west of the central business district (CBD). It has a population of over 5700 people. It was planned that Docklands would be a 24-hour city for visitors and local residents. It occupies 200 hectares — an area bigger than Melbourne's central business district (which is about 175 hectares).

The local residents of this 24-hour city rely on public transport, as few have cars (see table 1). Most residents are professionals (see table 2).

FIGURE 2 Convenient access to restaurants



TABLE 1 Number of cars per dwelling

Number of registered motor vehicles	Docklands (%)	Australia (%)
None	26.8	8.6
One motor vehicle	51.9	35.8
Two motor vehicles	16.2	36.1
Three or more vehicles	3.0	16.5
Number of motor vehicles not stated	2.0	3.0

TABLE 2 Selected occupations of people

Occupation	Docklands (%)	Australia (%)
Professionals	37.7	21.3
Managers	21.5	12.9
Community and personal service workers	6.5	9.7
Technicians and trade workers	5.7	14.2
Labourers	2.1	9.4
Machine operators and drivers	1.2	6.6

The lifestyle complexes offer a more convenient lifestyle for busy people. Many of the lifestyle complexes being constructed in locations close to the city include a range of facilities such as gymnasiums and swimming pools and provide security (figure 4). High-density living provides convenience but may result in a loss of privacy. In Rio de Janeiro (figure 5), lifestyle places, occupied by more affluent residents, contrast sharply with the shantytowns or favelas.

FIGURE 3 High-density living arrangements



FIGURE 4 Shared community facilities



FIGURE 5 A Rio de Janeiro lifestyle complex



FIGURE 6 Security measures and restricted public access to lifestyle living areas



ACTIVITIES

EXPLAIN

1 Study figures 2 to 4. Identify the features in the photographs that indicate that the people living in these ***places*** have the resources to choose to live in such ***environments***.

2 Create a cartoon that summarises the differences between a sea ***change*** and a tree ***change***.

3 Refer to the two living spaces shown in figure 5.
- **a** What similarities and differences can you see in the living spaces shown in figure 5?
- **b** What factors lead to the differences evident in these two spaces?

4 Refer to table 1.
- **a** Identify two key facts the table reveals about the number of cars Docklands residents have compared to the average for other Australian suburbs.
- **b** Think of a reason to explain this.

5 Refer to table 2.
- **a** Identify two key facts the table reveals about Docklands residents compared to the average for other Australian suburbs.
- **b** Think of a reason to explain this.

6 Refer to figure 1. Which features (existing or proposed) would make Docklands a 24-hour suburb?

APPLY

7 Use online resources to investigate the current state of the Docklands development in Melbourne. Identify the planned zones and features that are in operation and those that have been changed, removed or not built.

8 Based on your research, do you believe that the Docklands ***space*** provides an enjoyable lifestyle for the people who live there? Give reasons for your answer.

INVESTIGATE

9 In groups of four, use a graphics software program to create a concept wheel that explores the meaning of the word *lifestyle*. Display all the wheels in a class electronic presentation.

10 As a class, compare and discuss the lifestyle wheels that you produced in question 9. Is there a common view of lifestyle that is representative of the whole class?

8.11 Where is my place?

8.11.1 The place I live in

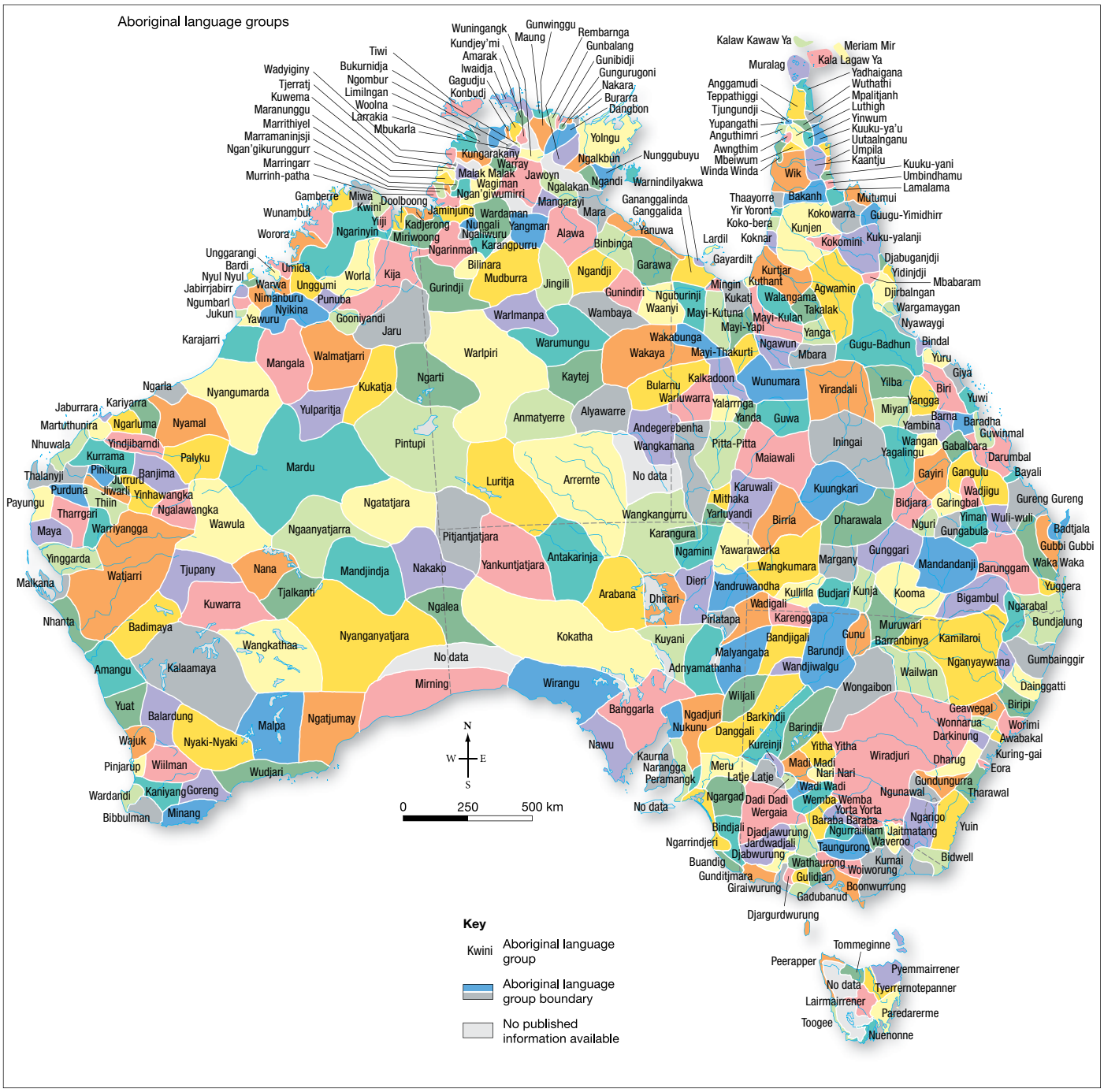
What is your neighbourhood or local place like? All of us live in a community, and these are often centred around the place where we live, go to school or work. Teenagers have different types of local places that have special meaning for them, each one at a different scale: their bedroom, home and neighbourhood.

When you live in a neighbourhood, you become familiar with all the things that help to create the character of the place. Sometimes a neighbourhood is made up of people who have similar interests

and beliefs, whether these be cultural, sporting, environmental or job-related. Other neighbourhoods have a mixture of people from different backgrounds, creating a vibrant, multicultural community identity. The fact that Australian neighbourhoods can be so different is what makes Australia such an interesting place to live in.

Neighbourhoods have always existed in Australia. The 'country' that is special to a particular group of Indigenous Australians is often based on language. There are about 29 clan groupings within the *environment* and *space* that the Sydney metropolitan area occupies today. Each tribe controlled a region that had definite boundaries (figure 1). Within each tribe, there were different dialects that overlapped. These dialects were spoken by different clans — groups of related families. Thus, these nations saw, and often still see, their neighbourhood as the region in which people spoke the same language and had the same customs, such as marriage rituals. People were, and are, socially connected.

FIGURE 1 The places belonging to the First Australians


Aboriginal language groups
Wuningangk
Gunwinggu
Maung
Rembarnga
Kundjey'mi
Gunbalang
Amarak
Gunibidji
Iwaidja
Gungurugoni
Gagudju
Nakara
Konbudj
Burarra
Dangbon
Tiwi
Bukurnidja
Ngombur
Limilngan
Woolna
Larrakia
Mbukarla
Wadyiginy
Tjerratj
Kuwema
Maranunggu
Marrithiyel
Marramaninjsi
Ngan'gikurunggurr
Marringarr
Murrinh-patha
Kungarakany
Warray
Malak Malak
Jawoyn
Wagiman
Ngan'giwumirri
Yolngu
Ngalkbun
Nunggubuyu
Ngandi
Warnindilyakwa
Ngalakan
Mangarayi
Gamberre
Miwa
Kwini
Doolboong
Wunambul
Jaminjung
Wardaman
Yiji
Kadjerong
Nungali
Yangman
Worora
Ngarinyin
Ngaliwuru
Miriwoong
Karangpurru
Ngarinman
Alawa
Mara
Binbinga
Ganggalida
Gananggalinda
Yanuwa
Unggarangi
Bardi
Nyul Nyul
Jabirrjabirr
Ngumbarl
Jukun
Umida
Warwa
Unggumi
Nimanburu
Punuba
Nyikina
Yawuru
Worla
Kija
Bilinara
Mudburra
Gurindji
Jingili
Ngandji
Garawa
Gooniyandi
Jaru
Karajarri
Warlmanpa
Gunindiri
Nguburinji
Waanyi
Wambaya
Mayi-Kutuna
Mayi-Kulan
Mayi-Yapi
Yanga
Takalak
Agwamin
Walangama
Kukatj
Mingin
Kuthant
Kurtjar
Gayardilt
Lardil
Koknar
Kunjen
Kokomini
Kuku-yalanji
Djabuganjdji
Yidinjdji
Mbabaram
Djirbalngan
Wargamaygan
Nyawaygi
Bindal
Yuru
Giya
Yuwi
Biri
Yangga
Barna
Baradha
Yambina
Guwinmal
Gabalbara
Darumbal
Bayali
Gangulu
Wadjigu
Gureng Gureng
Badtjala
Gubbi Gubbi
Waka Waka
Yuggera
Bundjalung
Ngarabal
Bigambul
Kamilaroi
Muruwari
Barranbinya
Gumbainggir
Nganyaywana
Dainggatti
Biripi
Worimi
Awabakal
Kuring-gai
Eora
Tharawal
Gundungurra
Ngunawal
Ngarigo
Yuin
Bidwell
Kurnai
Woiworung
Boonwurrung
Gulidjan
Gadubanud
Djargurdwurung
Giraiwurung
Gunditjmara
Buandig
Djabwurung
Jardwadjali
Taungurong
Waveroo
Jaitmatang
Ngurraiillam
Djadjawurung
Bindjali
Ngarrindjeri
Baraba Baraba
Yorta Yorta
Wergaia
Wemba Wemba
Wadi Wadi
Nari Nari
Latje Latje
Madi Madi
Wiradjuri
Dharug
Ngadjuri
Nukunu
Barkindji
Barindji
Danggali
Kureinji
Yitha Yitha
Meru
Kaurna
Narangga
Peramangk
Nawu
Banggarla
Wiljali
Wailwan
Wongaibon
Geawegal
Wonnarua
Darkinung
Kulin
Ngadjonji
Bandjigali
Gunu
Barundji
Wandjiwalgu
Malyangaba
Adnyamathanha
Kuyani
Pirlatapa
Karenggapa
Wadigali
Kullilla
Budjari
Kunja
Kooma
Dieri
Yandruwandha
Arabana
Dhirari
Wangkumara
Margany
Gunggari
Mandandanji
Baranggam
Karangura
Ngamini
Yawarawarka
Wangkangurru
Yarluyandi
Mithaka
Karuwali
Kuungkari
Birria
Dharawala
Bidjara
Garingbal
Yiman
Wuli-wuli
Nguri
Gungabula
Yalarrnga
Bularnu
Warluwarra
Kalkadoon
Wunumara
Yirandali
Yilba
Miyan
Andegerebenha
Wangkamana
Pitta-Pitta
Iningai
Maiawali
Anmatyerre
Alyawarre
Kaytej
Warlpiri
Warumungu
Wakaya
Wakabunga
Mayi-Thakurti
Ngawun
Mbara
Gugu-Badhun
Yanda
Guwa
Kukatja
Ngarti
Pintupi
Luritja
Arrernte
No data
Ngatatjara
Ngaanyatjarra
Pitjantjatjara
Yankuntjatjara
Antakarinja
Nakako
Mandjindja
Tjalkanti
Nana
Tjupany
Watjarri
Wangkathaa
Nyanganyatjara
Ngalea
Kokatha
No data
Mirning
Wirangu
Ngatjumay
Malpa
Nyaki-Nyaki
Wiilman
Wudjari
Kaniyang
Goreng
Minang
Kuwarra
Badimaya
Kalaamaya
Amangu
Yuat
Balardung
Wajuk
Pinjarup
Wardandi
Bibbulman
Mardu
Palyku
Kurrama
Pinikura
Jurruru
Jiwarli
Yinhawangka
Ngalawangka
Wawula
Warriyangga
Tharrgari
Thiin
Payungu
Thalanyji
Purduna
Banjima
Maya
Yinggarda
Malkana
Nhanta
Nyangumarda
Yulparitja
Mangala
Walmatjarri
Ngarla
Kariyarra
Jaburrara
Martuthunira
Ngarluma
Yindjibarndi
Nhuwala
Nyamal
Kukatja
Ngarla
Ngarluma
Yindjibarndi
Nyamal
Kariyarra
Jaburrara
Martuthunira
Nhuwala
Kurrama
Pinikura
Jurruru
Jiwarli
Thiin
Payungu
Thalanyji
Purduna
Banjima
Yinhawangka
Ngalawangka
Tharrgari
Maya
Warriyangga
Wawula
Yinggarda
Malkana
Nhanta
Watjarri
Tjupany
Nana
Mandjindja
Tjalkanti
Kuwarra
Badimaya
Wangkathaa
Nyanganyatjara
Ngalea
Kalaamaya
Amangu
Yuat
Balardung
Wajuk
Pinjarup
Wiilman
Wudjari
Kaniyang
Goreng
Minang
Wardandi
Bibbulman
Malpa
Ngatjumay
Nyaki-Nyaki
Mirning
Wirangu
No data
Kokatha
Nyanganyatjara
Ngalea
Ngatatjara
Ngaanyatjarra
Pitjantjatjara
Yankuntjatjara
Antakarinja
Nakako
Mandjindja
Tjalkanti
Nana
Tjupany
Watjarri
Kuwarra
Badimaya
Kalaamaya
Amangu
Yuat
Balardung
Wajuk
Pinjarup
Wiilman
Wudjari
Kaniyang
Goreng
Minang
Wardandi
Bibbulman
Mardu
Palyku
Kurrama
Pinikura
Jurruru
Jiwarli
Yinhawangka
Ngalawangka
Wawula
Warriyangga
Tharrgari
Thiin
Payungu
Thalanyji
Purduna
Banjima
Maya
Yinggarda
Malkana
Nhanta
Nyangumarda
Yulparitja
Mangala
Walmatjarri
Ngarla
Kariyarra
Jaburrara
Martuthunira
Ngarluma
Yindjibarndi
Nhuwala
Nyamal
Kukatja
Ngarti
Pintupi
Luritja
Arrernte
No data
Anmatyerre
Alyawarre
Kaytej
Warlpiri
Warumungu
Wakaya
Wakabunga
Mayi-Thakurti
Ngawun
Mbara
Gugu-Badhun
Bindal
Yuru
Giya
Yuwi
Biri
Yangga
Barna
Baradha
Yambina
Guwinmal
Gabalbara
Darumbal
Bayali
Gangulu
Wadjigu
Gureng Gureng
Badtjala
Gubbi Gubbi
Waka Waka
Yuggera
Bundjalung
Ngarabal
Bigambul
Kamilaroi
Muruwari
Barranbinya
Gumbainggir
Nganyaywana
Dainggatti
Biripi
Worimi
Awabakal
Kuring-gai
Eora
Tharawal
Gundungurra
Ngunawal
Ngarigo
Yuin
Bidwell
Kurnai
Woiworung
Boonwurrung
Gulidjan
Gadubanud
Djargurdwurung
Giraiwurung
Gunditjmara
Buandig
Djabwurung
Jardwadjali
Taungurong
Waveroo
Jaitmatang
Ngurraiillam
Djadjawurung
Bindjali
Ngarrindjeri
Baraba Baraba
Yorta Yorta
Wergaia
Wemba Wemba
Wadi Wadi
Nari Nari
Latje Latje
Madi Madi
Wiradjuri
Dharug
Ngadjuri
Nukunu
Barkindji
Barindji
Danggali
Kureinji
Yitha Yitha
Meru
Kaurna
Narangga
Peramangk
Nawu
Banggarla
Wiljali
Wailwan
Wongaibon
Geawegal
Wonnarua
Darkinung
Kulin
Ngadjonji
Bandjigali
Gunu
Barundji
Wandjiwalgu
Malyangaba
Adnyamathanha
Kuyani
Pirlatapa
Karenggapa
Wadigali
Kullilla
Budjari
Kunja
Kooma
Dieri
Yandruwandha
Arabana
Dhirari
Wangkumara
Margany
Gunggari
Mandandanji
Baranggam
Karangura
Ngamini
Yawarawarka
Wangkangurru
Yarluyandi
Mithaka
Karuwali
Kuungkari
Birria
Dharawala
Bidjara
Garingbal
Yiman
Wuli-wuli
Nguri
Gungabula
Yalarrnga
Bularnu
Warluwarra
Kalkadoon
Wunumara
Yirandali
Yilba
Miyan
Andegerebenha
Wangkamana
Pitta-Pitta
Iningai
Maiawali
Anmatyerre
Alyawarre
Kaytej
Warlpiri
Warumungu
Wakaya
Wakabunga
Mayi-Thakurti
Ngawun
Mbara
Gugu-Badhun
Yanda
Guwa
Kukatja
Ngarti
Pintupi
Luritja
Arrernte
No data
Ngatatjara
Ngaanyatjarra
Pitjantjatjara
Yankuntjatjara
Antakarinja
Nakako
Mandjindja
Tjalkanti
Nana
Tjupany
Watjarri
Kuwarra
Badimaya
Kalaamaya
Amangu
Yuat
Balardung
Wajuk
Pinjarup
Wiilman
Wudjari
Kaniyang
Goreng
Minang
Wardandi
Bibbulman
Mardu
Palyku
Kurrama
Pinikura
Jurruru
Jiwarli
Yinhawangka
Ngalawangka
Wawula
Warriyangga
Tharrgari
Thiin
Payungu
Thalanyji
Purduna
Banjima
Maya
Yinggarda
Malkana
Nhanta
Nyangumarda
Yulparitja
Mangala
Walmatjarri
Ngarla
Kariyarra
Jaburrara
Martuthunira
Ngarluma
Yindjibarndi
Nhuwala
Nyamal
Kukatja
Ngarti
Pintupi
Luritja
Arrernte
No data
Anmatyerre
Alyawarre
Kaytej
Warlpiri
Warumungu
Wakaya
Wakabunga
Mayi-Thakurti
Ngawun
Mbara
Gugu-Badhun
Bindal
Yuru
Giya
Yuwi
Biri
Yangga
Barna
Baradha
Yambina
Guwinmal
Gabalbara
Darumbal
Bayali
Gangulu
Wadjigu
Gureng Gureng
Badtjala
Gubbi Gubbi
Waka Waka
Yuggera
Bundjalung
Ngarabal
Bigambul
Kamilaroi
Muruwari
Barranbinya
Gumbainggir
Nganyaywana
Dainggatti
Biripi
Worimi
Awabakal
Kuring-gai
Eora
Tharawal
Gundungurra
Ngunawal
Ngarigo
Yuin
Bidwell
Kurnai
Woiworung
Boonwurrung
Gulidjan
Gadubanud
Djargurdwurung
Giraiwurung
Gunditjmara
Buandig
Djabwurung
Jardwadjali
Taungurong
Waveroo
Jaitmatang
Ngurraiillam
Djadjawurung
Bindjali
Ngarrindjeri
Baraba Baraba
Yorta Yorta
Wergaia
Wemba Wemba
Wadi Wadi
Nari Nari
Latje Latje
Madi Madi
Wiradjuri
Dharug
Ngadjuri
Nukunu
Barkindji
Barindji
Danggali
Kureinji
Yitha Yitha
Meru
Kaurna
Narangga
Peramangk
Nawu
Banggarla
Wiljali
Wailwan
Wongaibon
Geawegal
Wonnarua
Darkinung
Kulin
Ngadjonji
Bandjigali
Gunu
Barundji
Wandjiwalgu
Malyangaba
Adnyamathanha
Kuyani
Pirlatapa
Karenggapa
Wadigali
Kullilla
Budjari
Kunja
Kooma
Dieri
Yandruwandha
Arabana
Dhirari
Wangkumara
Margany
Gunggari
Mandandanji
Baranggam
Karangura
Ngamini
Yawarawarka
Wangkangurru
Yarluyandi
Mithaka
Karuwali
Kuungkari
Birria
Dharawala
Bidjara
Garingbal
Yiman
Wuli-wuli
Nguri
Gungabula
Kalkadoon
Wunumara
Yirandali
Yilba
Miyan

8.11.2 Describing our neighbourhoods

mental map a drawing or map that contains our memory of the layout and distribution of features in a place

Because nearly 90 per cent of Australians live in towns and cities, most people are likely to live in a street that is part of a suburb, town or city, and which itself is part of a state or territory. On the other hand, there are Australians who do not live in urban areas, but still live in their own communities that are just as distinctive as neighbourhoods in towns and cities. How can we describe where our local place is and what it is like? Sometimes, people try to use words to do this, but it is not an easy task. Geographers have no such trouble, however; they can use maps.

FIGURE 2 Mental map of Jayden's local place (by Jayden)

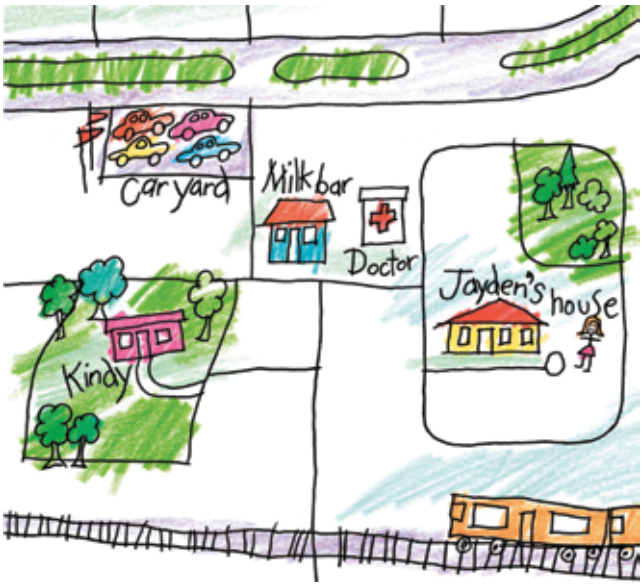
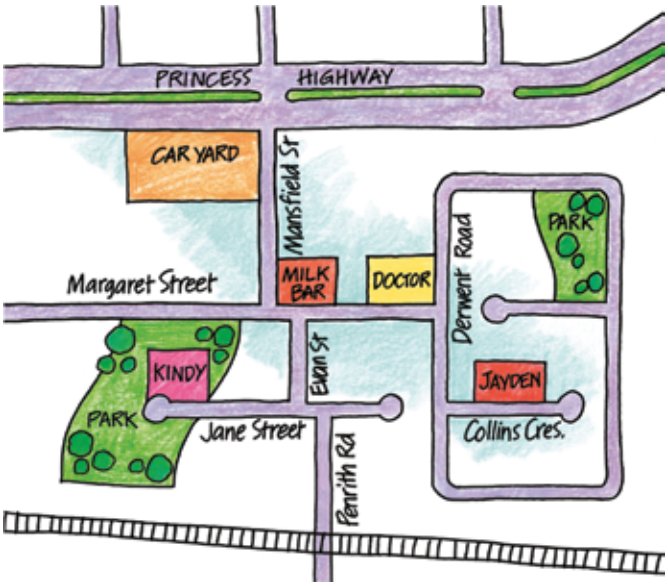


FIGURE 3 Mental map of Jayden's local place (by Annette, Jayden's mother)



eBook*plus*

Interactivity
How did they live here?
Use this interactivity to discover how Indigenous Australians survived in the Australian environment.
Searchlight ID: int-3091

sketch map a simple labelled drawing of an area using a bird's-eye view

ACTIVITIES

IDENTIFY

1 Figures 2 and 3 show two mental maps of the same neighbourhood ***place***. One is drawn by Jayden, a Year 7 boy, and the other is drawn by his mother. Compare the two maps by drawing up a table like the one below and filling in the spaces.

	Features that are different	Features that are similar
Land use		
Transport		
Street layout		
Relative sizes		
Names of places		
Other		

EXPLAIN

2 Suggest reasons to explain the major similarities and differences between the maps drawn by Jayden and his mother. Think about factors such as age, duties during the day, transport and friendships.

APPLY

3 Create a **sketch map** of your neighbourhood or local ***place***. Locate your house in the centre of the sheet and work outwards from there. The map should be as detailed as possible. Include features such as:

- streets and their names
- houses of friends or family
- shops, parks, trees, post boxes, telephone poles, pedestrian crossings, railway lines and stations
- anything you can remember, but the map must be drawn from memory.

Present the map using geographical rules (BOLTSS). Since you are not drawing the map to a ***scale***, write 'Not to scale' in the correct position. Remember to use conventional colours and symbols as far as possible. Compare your mental map to an actual map of your neighbourhood.

a In what ways was your map accurate?
b Which features did you not mark on your map?
c Which parts of your neighbourhood did you know well and which did you not know well?
d Think of reasons to explain your answers to (c).

GEOskills TOOLBOX

Sketch maps

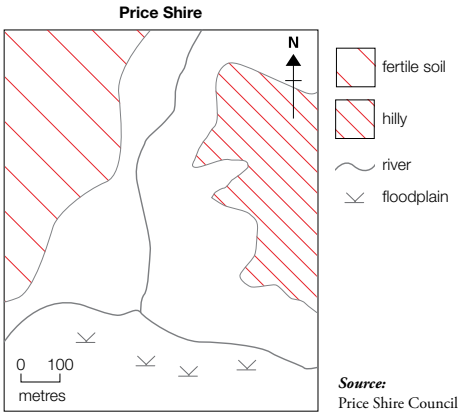
A sketch map is a simple, labelled drawing of an area using a birds-eye view. Figures 2 and 3 show Jayden's neighbourhood. The sketch map is not supposed to record everything that you can see; it summarises the more important features of a place.

eBook*plus* ONLINE ONLY

8.12 SkillBuilder: Constructing a basic sketch map

What is a sketch map?

A sketch map is a map drawn from an aerial photograph or developed during field work that identifies the main features of an area. Sketch maps are used to show the key elements of an area, so other more detailed characteristics are not shown.



eLesson

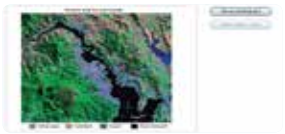
Watch this video to learn how to construct a basic sketch map.



Searchlight ID: eles-1661

Interactivity

Try this interactivity to learn how to construct a basic sketch map.



Searchlight ID: int-3157

FOCUS ON FIELDWORK

Why do people choose to live here?

Preparation

Identify properties in an area that has real estate signs or advertisements promoting the selling points of the property. This may also be accessed by looking at Real Estate sites online.

Fieldwork

Record the points being promoted on a at least three signs.

What are the common selling points for properties selling in your chosen area?

Reflection

Create your own sign (no more than 100 words) to promote the special features of a place of your choice. To communicate a sense of place, include an image.



8.13 Where would you like to live?

8.13.1 What makes this place so liveable?

Where is your favourite place in Australia? Have you been to a holiday paradise, one that you think would be the perfect place to live? Is the climate perfect, the scenery spectacular? Is it safe, fun and the place for adventure? Is this place in a city, in the wilderness or in the next street? Is it paradise because your friends or family live there or because of the natural or built environment?

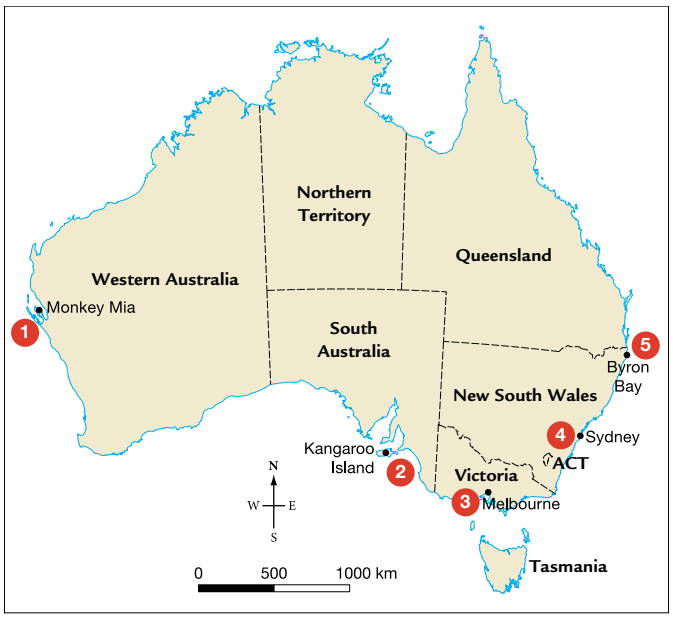
Among the most popular and beautiful tourist destinations in Australia are the Great Barrier Reef, Uluru, Melbourne, Sydney, the Gold Coast, the Great Ocean Road, Monkey Mia, Kakadu, the Tasmanian Wilderness, the Blue Mountains, Port Arthur, Byron Bay, Kangaroo Island and Ningaloo Reef. Many of these places have unique landscapes, located within naturally stunning environments. Four of these are predominantly **built environments**: Sydney, Melbourne, the Gold Coast and Port Arthur. The remaining 11 places are best known for their natural, often remote, and almost **wilderness** environments.

built environment a place that has been constructed or created by people

wilderness a natural place that has been almost untouched or unchanged by the actions of people

Some of these wonderful places are found in or close to cities and large towns; some have significant local populations; and some are quite remote. They are all places that attract large numbers of visitors every year. People come to see or experience an aspect of the local environment that brings them pleasure. These places are often perfect for a holiday but they may also be a place to live. Is it mostly the excitement of a big city, natural beauty, or some other factor that makes you decide which place is the most liveable?

FIGURE 1 Five of Australia's most popular places for tourists



Source: Spatial Vision

1 Monkey Mia is an environment where you can experience natural wildlife by interacting with dolphins. Monkey Mia is located in Shark Bay on the coast of Western Australia, 850 kilometres north of Perth. For over 40 years, a small pod of dolphins has come ashore to connect with beachgoers. The Department of Environment and Conservation provides staff who supervise the feeding of fish to these dolphins each day. It is an unusual opportunity for people to see wild dolphins up close, quite near to the shore. Monkey Mia is a place of great natural beauty without a huge tourist resort attached. Most visitors camp. It is an important stop on the around-Australia tourist trail. Fewer than 800 residents currently live near the Monkey Mia Resort.



2 Kangaroo Island is a place of natural beauty. It is Australia's third largest island, found about 160 kilometres south of Adelaide. It is a wildlife lover's paradise, being home to many native Australian animals in their natural habitats, including koalas, kangaroos, seals and penguins. It has remote, unspoiled beaches and interesting rocky outcrops. Although first settled in the late 1830s, its present population of over 4200 is the highest it has ever been. It was originally settled as a fishing and farming community but today is better known as a tourist destination.



3 Melbourne is the second-largest and most **liveable city** in Australia (2011 and 2014). It is the capital of Victoria and home to about 4.1 million residents. It is an attractive destination for tourists, who visit to enjoy its major sporting and cultural events, shopping, restaurants and theatre. Melbourne is located beside Port Phillip Bay and on the Yarra River. It is not a city known for its beautiful natural environment but it has become known for its distinctive laneways, bars and café culture.

liveable city a city that people want to live in, which is safe, well planned and prosperous and has a healthy environment



4 Sydney is a built environment in a beautiful setting and is Australia's largest and oldest city. It is often called the 'Harbour City'. Sydney is popular with both domestic and international tourists and is home to 4.6 million residents. It has many attractions, including restaurants, beautiful beaches, theatres, galleries and iconic landmarks. It has a beautiful natural environment with varied experiences provided by the built environment. This makes it an extremely popular destination for everyone.



5 Byron Bay is a beachside town in northern New South Wales, located 160 kilometres south of Brisbane. Byron Bay is a very relaxed place with a local community that includes many artists and retired hippies. It is an important surfing place, with easy access to offshore reefs and stunning beaches. It has become a popular place for 'schoolies' end-of-year celebrations. Byron Bay has a population of about 30 000 people, who rely heavily on tourism and agriculture for their income.



ACTIVITIES

IDENTIFY

1 Brainstorm a list of the features of your most liveable ***place***.
2 Is there a ***place*** in Australia that you have been to or heard about that is your most liveable ***place***? Locate this ***place*** on a map and use images from the internet or magazines to explain how it fulfills your list of features from question 1 above.

EXPLAIN

3 Is your most liveable ***place*** in a natural or a built ***environment*** or a mixture of the two?
4 What would be the advantages and disadvantages of living in your most liveable ***place***?
5 After reading the paragraphs numbered 1 to 5, which of these ***place*** is most similar to your most liveable ***place***? Explain your answer.

APPLY

6 If you were looking for a ***place*** to retire, which of the ***places*** in figure 1 would be best and why?
7 If you wished to work as a national park ranger, which of the ***places*** in figure 1 would be best and why?
8 If you were planning a career in the theatre, which of the ***places*** in figure 1 would be best and why?
9 If you wished to live in a relaxed coastal ***environment*** close to a capital city, which of the ***places*** in figure 1 would be best and why?

THINK

10 Design a map of your most liveable ***place***. Consider the natural and built ***environments***; distance to a city, services, job and recreational opportunities; climate; and lifestyle. Annotate your map to explain why this is where you would like to live. Use the **Nothing like Australia** weblink in your eBookPLUS to help find your ideal location.

eBookplus
Weblink
Nothing like Australia

eBookplus ONLINE ONLY

8.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

8.5 SkillBuilder: Interpreting population profiles

8.5.1 Tell me

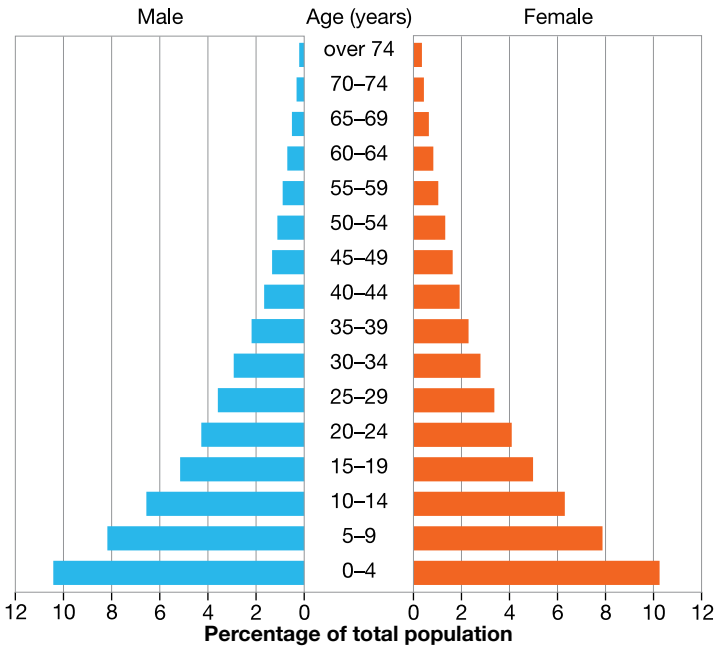
What is a population profile?

A population profile, sometimes called a population pyramid, is a bar graph that provides information about the age and gender of a population. The bars identify the proportion of a country's population within a particular age group. The graph is split to show information about males and females. The shape of the population profile tells us about a particular population.

Why are population profiles useful?

Population profiles help us to interpret and understand a list of statistics. Any patterns are easily identified and compared. A triangular shape that is widest at the base, as in figure 1, tells us that the population is growing rapidly. A square shape, as in figure 2, indicates that population growth is slow. An inverted triangle, as in figure 3 (a prediction of Germany's population in 2050), tells us that there is negative growth — that is, the population is decreasing.

FIGURE 1 Population profile of Niger, 2009



A population profile is used to show us the structure of a population.

- If the lower bars of the profile are wide, then the population is young (that is, there is a larger proportion of young people than older people in the population).
- If the upper bars of the profile are wide, then the population is ageing.
- Comparisons can be made of the numbers of males and females within a population.
- Exceptions, particularly indents, in the shape may be due to significant events, such as war, disease, emigration or natural disasters.
- Expansions in the shape may be due to factors such as immigration, changes in birth control laws or the ending of a war.

Population profiles are useful for:

- comparing populations of different countries or places
- planning future urban developments

- determining the facilities required in an area — for example, a widening in the bars showing the 5–14 years age groups means more schools will be needed, while a widening in the bars showing the 60+ years age groups means aged care facilities will be required
- planning by governments for services for the future.

FIGURE 2 Population profile of Germany, 2009

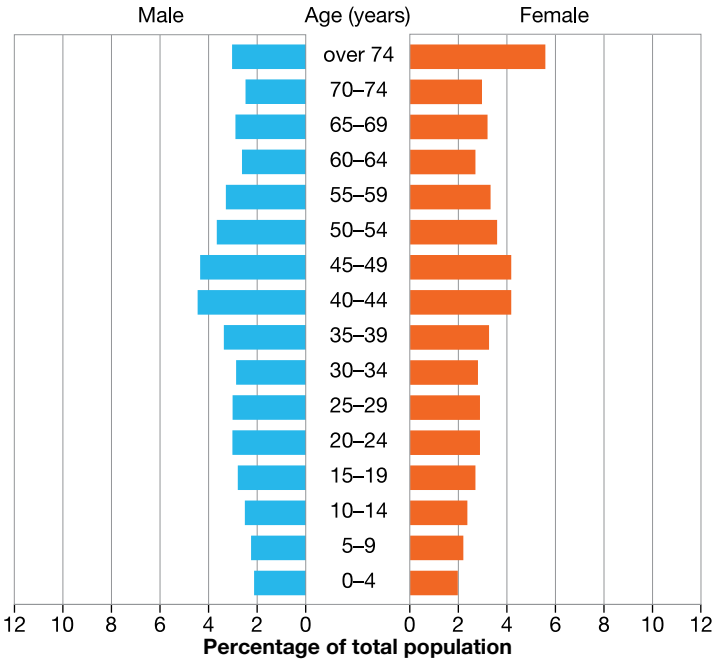
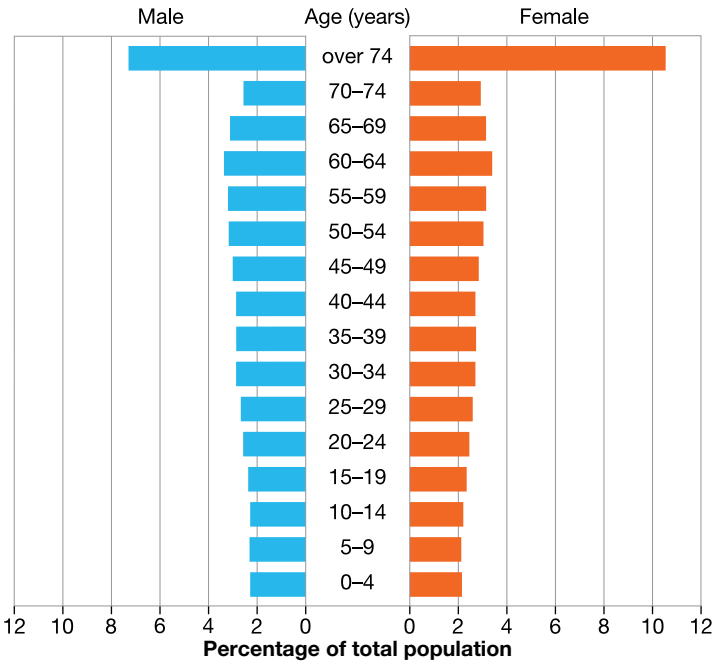


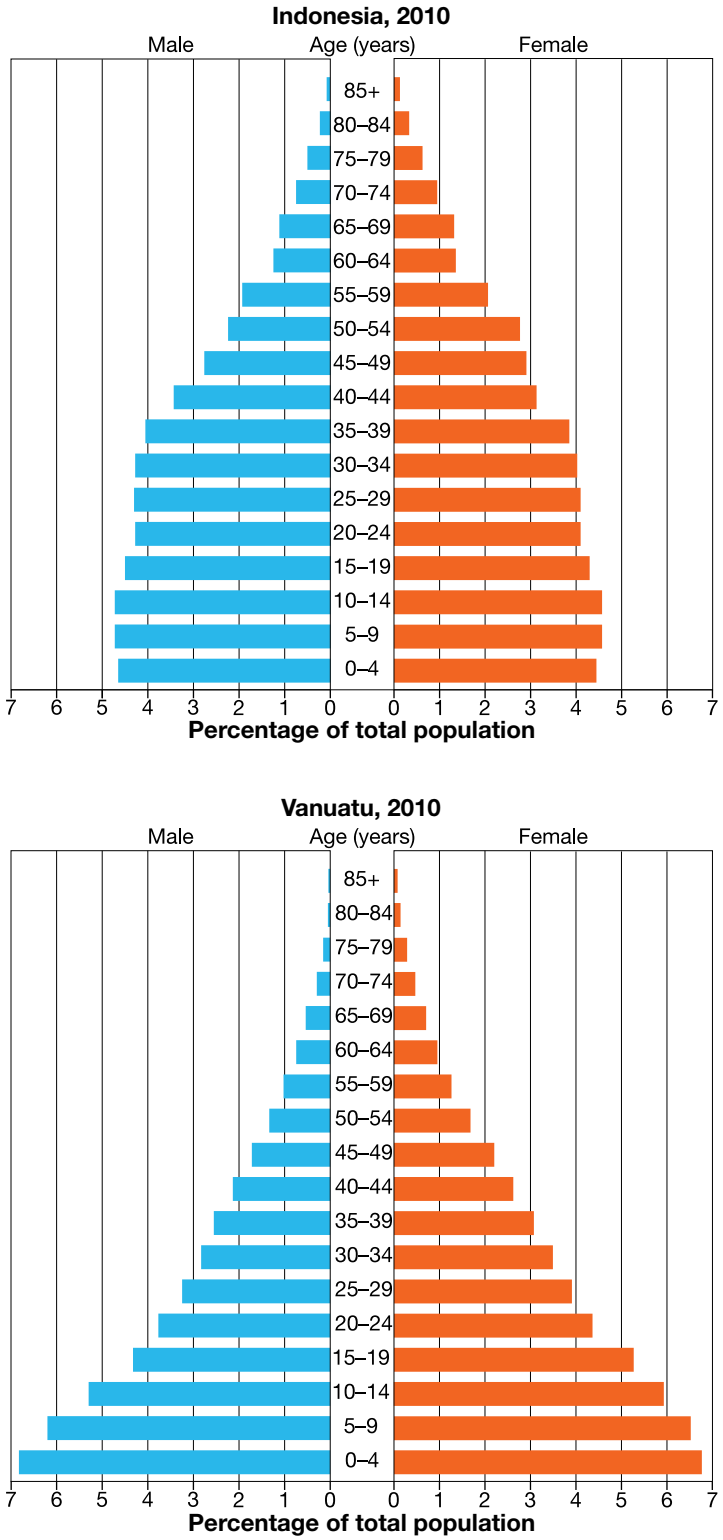
FIGURE 3 Population profile of Germany, 2050



Model

In figure 4, Indonesia's profile does not fit a triangular shape; it is not very wide at the bottom, suggesting that it has relatively fewer young people and an ageing population. The profile of Vanuatu is widest at the base (the 0–4 years age group) and tapers in a triangular shape, indicating that it has a youthful population. Vanuatu will have to consider the needs of its population carefully in the future.

FIGURE 4 Population profiles of Indonesia and Vanuatu, 2010



In Vanuatu, 41.8 per cent of the population can be regarded as dependent (very young or very old), but in Indonesia the dependent population makes up 32.5 per cent of the population. People in Vanuatu's population could be expected to live into their 70s, whereas those in Indonesia can expect to live into their 80s.

In Vanuatu the gender balance is skewed to males (the bars show that the male population is slightly larger than that of females in most age groups), whereas in Indonesia the numbers are more evenly balanced (although the proportion of females increases in the 60+ years age groups).

A clear comparison of population profiles has:
- identified the countries to be compared
- considered the three categories of level of dependence (see step 2)
- provided quantification (numbers) from the population profile
- compared male populations with female populations.

eBookplus

eLesson
Interpreting population profiles
Searchlight ID: eles-1704

8.5.2 Show me

How to compare population profiles

You will need:

- two population profiles to compare — these can be for the same place at different times (as in figures 2 and 3), or for two different places at the same time (as in figure 4).

Procedure:

STEP 1

To complete a comparison of population profiles, you must have two or more population profiles for the same place at different times, or for different places at the same time. For this example, we will use the population profiles for Indonesia and Vanuatu shown in figure 4.

STEP 2

Populations can be broadly grouped into three categories according to the level of dependence of the age groups:
- children (0–14 years) — dependent population, i.e. those that need others to provide their basic needs
- adults (15–64 years) — economically productive and independent, i.e. the workforce of a population
- aged (65 years and over) — economically inactive and dependent, i.e. no longer earning money and therefore relying on other means of support such as pensions or savings.

A population is considered to be old when less than 30 per cent of the population is younger than 15 years and more than 6 per cent is aged 65 years and over. A population is considered to be young when more than 30 per cent of the population is younger than 15 years and less than 6 per cent is aged 65 years and over.

eBookplus

Weblinks
- Population pyramid
- Population profiles

For each population profile, calculate the percentage of males and females in each of the three categories described above. You can do this by using the **Population pyramid** weblink in the Resources tab and selecting the country and year that you want to research. Alternatively, use the **Population profiles** weblink in the Resources tab and select the report type 'Population by five year age groups', then choose the area and year that you want to research. You will find that population figures (as a percentage or the actual number of people) are produced for each age group. Calculate the total population in each of the three categories of dependence. What does this tell you about the population in each of the population profiles?

STEP 3

Look for patterns revealed by each population profile. Look at the gender structure — the number of males and females — of the graph. Is it in balance — that is, are there as many males as females? Often there are more females than males in the older age groups because females tend to have a longer lifespan. Migration can result in the movement of one gender more than another. War can affect the gender structure as a higher proportion of men may be killed. After a war, however, more births are likely to occur. Government policies such as the one-child policy of China (since 1979, and became less restrictive in 2016), where males are favoured, has changed the gender balance in affected countries. Write a statement about the balance of the population profiles.

Are the profile shapes for Indonesia and Vanuatu similar? If not, at what age groupings do the variations appear? Write a few statements to summarise your findings. Some key points you could cover include Vanuatu's economic development and Indonesia's mass education and family planning programmes of the 1990s.

STEP 4

Consider any unusual aspects. Traditionally, population profiles were called population pyramids because they were shaped like a pyramid or triangle — wide at the base and narrow at the top. Are there any indents (places where the graph narrows unexpectedly) or extended age groupings? Can you suggest why these may occur? Historical and economic events are an important consideration. A country's history — for example, conflicts or natural disasters — can often explain unusual

changes. When economic times are tough, fewer children are born; when economic times are good, parents feel they have the finances to support larger families. You will need to research the background of a country to gain information that will allow you to make an accurate interpretation of its population figures.

8.5.3 Let me do it

Developing my skills

Using the **Population pyramid** weblink in the Resources tab, find the population profile for South Africa in 2010 and compare it with the population profile for Thailand in 2010 by writing a paragraph about population structure (using the steps above to help you).

Spend some additional time on the website looking at the changes in population pyramids over time and for other countries. It is amazing what you will discover!

Questions

1. What percentage of people in Thailand are aged less than 10 years? Compare this with the figure for South Africa — what percentage of people in that country are aged less than 10 years?
2. In which country, South Africa or Thailand, is a female most likely to live longest?
3. Which population profile is narrowest in the 0–4 years age group?
4. At what point does the population structure for South Africa take on a pyramid shape?
5. Which country, South Africa or Thailand, is likely to have more people in the workforce in 2025? Give reasons for your answer.

eBook*plus*

Interactivity
Interpreting population profiles
Searchlight ID: int-3284

Checklist

I have:

- identified the countries to be compared
- considered the three categories of level of dependence
- provided quantification (numbers) from the population profile
- identified and utilised male population and female population numbers
- compared the total populations in each gender.

Skills questions

1. Population profiles are used to show:
   a. the number of people at a place
   b. the number of men in a population
   c. the number of women in a population
   d. the structure of a population.
2. A population profile includes information about:
   a. age
   b. housing
   c. health
   d. history.
3. Suggest why population profiles use five-year age groupings.
4. Why is it easier to deal with population profiles using percentage figures rather than total population numbers?

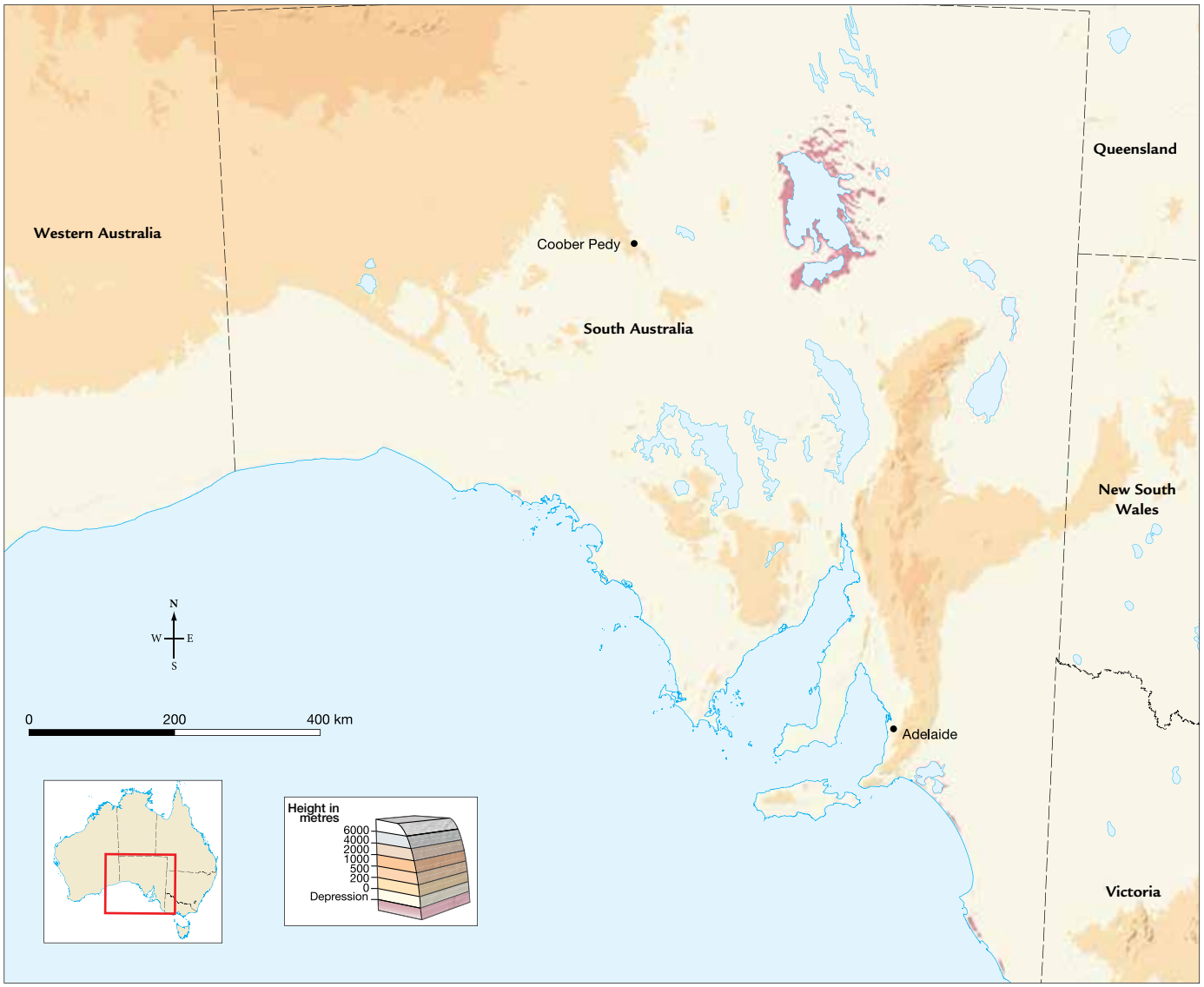
8.9 Are rural communities sustainable?

8.9.1 Rural communities

Rural communities are an important part of Australia's social identity, but they are facing significant change and challenges in maintaining their population. Many are experiencing a decline because young people are leaving in search of education and employment. Some rural communities are able to alter this trend, and are surviving against the odds. Others have not fared so well.

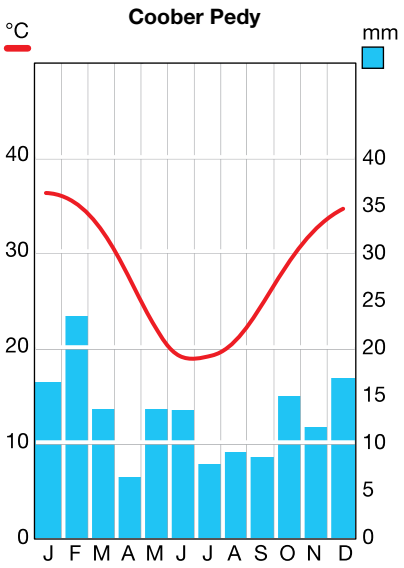
Coober Pedy is a vibrant multicultural town in the far north of South Australia, 850 kilometres north of Adelaide and 700 kilometres south of Alice Springs. The town is located in one of the most arid environments of Australia.

FIGURE 1 Coober Pedy location map



Source: Spatial Vision

FIGURE 2 Climate graph for Coober Pedy, South Australia



For thousands of years, Aboriginal peoples walked the stony desert of the Coober Pedy area as part of their rotational occupation of land. The traditional custodians of the land are the Antakirinja people. The town's name may come from the name Kupa Piti, meaning 'white man's hole'. Opal was discovered in February 1915 and, after several cycles of boom and bust, the town expanded rapidly during the 1960s. Opal developed into a multi-million dollar industry, and the town is sometimes called the 'Opal Capital of the World'.

Opal continues to be important to Coober Pedy's identity and economy, but the town now draws its income from mining services, tourism and public services. Coober Pedy has a large Aboriginal community, and the town's population has now declined to an estimated 3500.

8.9.2 What does the future hold?

Coober Pedy is widely known for its underground housing (see figure 4), an effective and environmentally friendly response to the town's searing summer heat and chilly desert evenings. Recent exploration has revealed significant deposits of iron ore, copper, gold and coal in the area, along with platinum, palladium and rare earths.

The location of the town makes it an ideal centre for mining services, and a base for the delivery of state and federal government services in the region. This presents an opportunity for the town to reverse its steady population decline and again see growth in its economy and population.

FIGURE 3 Along with other South Australian fields, Coober Pedy produces most of the world's opal. Mullock heaps create Coober Pedy's distinctive landscape.



FIGURE 4 Much of Coober Pedy lives underground to take advantage of the cooler underground climate.



Coober Pedy has good hospital and medical services, primary and secondary schooling, a TAFE campus, childcare services and police. However, these services are under some pressure, and there is a continuing problem with the recruitment and retention of medical professionals. This rural environment is extremely remote, so many of the **pastoral** properties in the region have been linked to telecommunication services since 1987. The Stuart Highway provides the main transport and service route for the town.

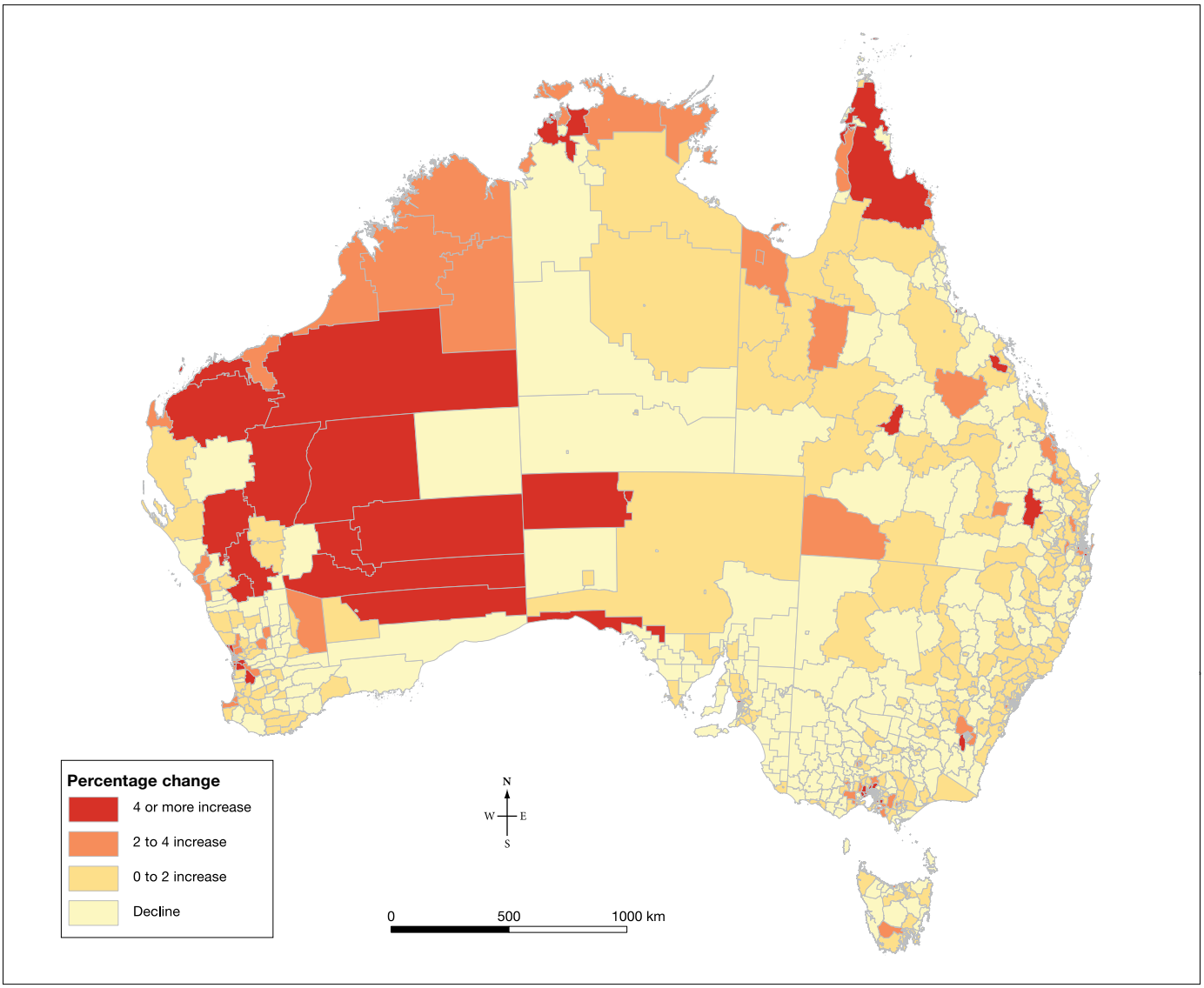
pastoral describes land used for keeping, or grazing of, sheep or cattle

8.9.3 A question of survival

Many rural communities are facing global pressures, such as more overseas competition and a change in the value of the Australian dollar. The rural communities that are not experiencing the trend of people moving to urban areas (figure 5) all have one thing in common: they have discovered another source of income. They may have shifted their focus to growing olives or grapes, or perhaps made use of a natural environmental resource such as a nearby national park.

In some cases, a rural community is unable to reinvent itself or tackle the problem effectively. The loss of an industry such as mining may have terrible effects on employment, leaving the resident population with lower incomes and few job prospects.

FIGURE 5 The rate of population change across Australia between 2010 and 2011



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 Describe the location of Coober Pedy.

EXPLAIN

2 Why are rural communities under threat?

3 Refer to figure 5. Which regions of Australia are experiencing negative population growth (less than 0.0 per cent)? Where are the rates of highest population growth occurring (more than 4.0 per cent)?

INVESTIGATE

4 Use an internet mapping tool to view a satellite image of Coober Pedy. What clues can you see that tell you about the climate of Coober Pedy? Can you see the mullock heaps, as shown in figure 3?

PREDICT

5 Some rural communities revolve around only one particular industry, such as tourism or mining. What happens to the town when this industry fails? For example, a finite resource such as coal might be mined out, or a key tourist attraction such as a coral reef might be destroyed. In two separate columns, list the social and economic impacts of a failed industry.

APPLY

6 Sometimes, when rural communities begin to fail and their populations begin to decline, drastic measures need to be taken. The town of Trundle featured in an ABC series in which families could rent a house in the town for $1 a month, in order to help stimulate the rural community and economy. In a small group, come up with a solution that could be put to the Council of Coober Pedy to help them reverse their population decline.

8.12 SkillBuilder: Constructing a basic sketch map

8.12.1 Tell me

What is a basic sketch map?

A basic sketch map is a map drawn from an aerial photograph or developed during field work that identifies the main features of an area. It is different from a précis map, in which the cartographer opts to include or leave out certain features.

Why are basic sketch maps useful?

Basic sketch maps are used to show the key elements of an area, so other more detailed characteristics are not shown.

They are also useful for:

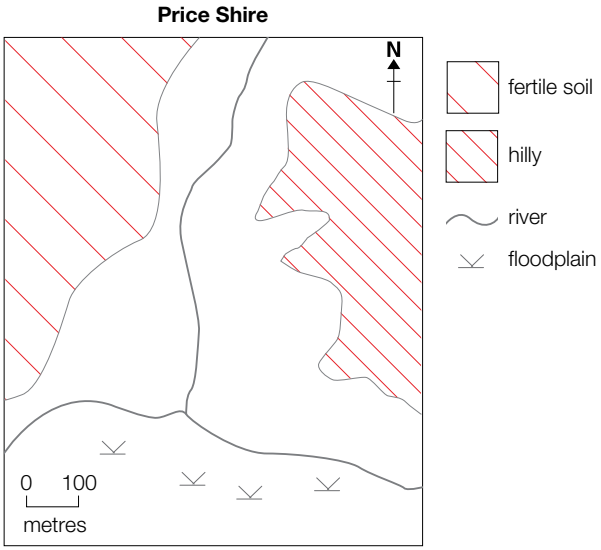
- summarising an idea for presentations about a feature
- identifying and communicating key features or characteristics of an area.

Model

A basic sketch map has:

- been drawn in pencil
- not tried to show everything in great detail
- been coloured using a key/legend
- included BOLTSS.

FIGURE 1 Sketch map of land use in Price Shire



Source: Price Shire Council

8.12.2 Show me

How to construct a basic sketch map

You will need:

- an aerial photograph
- a piece of paper on which to draw the map
- a light grey pencil
- coloured pencils
- a ruler
- an eraser.

Procedure:

To complete a basic sketch map from an aerial photograph of a place, complete the following steps.

FIGURE 2 Aerial photograph of Darwin, Northern Territory



eBook*plus*

eLesson
Constructing a basic sketch map
Searchlight ID: eles-1661

STEP 1

Determine the relevant area of the aerial photograph that you want to use to make a basic sketch map.

FIGURE 3 The area for the sketch map is identified.



STEP 2

Rule a border on your page within which to create your map. Keep the border the same size as the area of the photograph you are planning to draw, to avoid scale issues.

STEP 3

Identify the feature(s), and their extent, that you are going to transfer onto your basic sketch map. Look for both natural and human features.

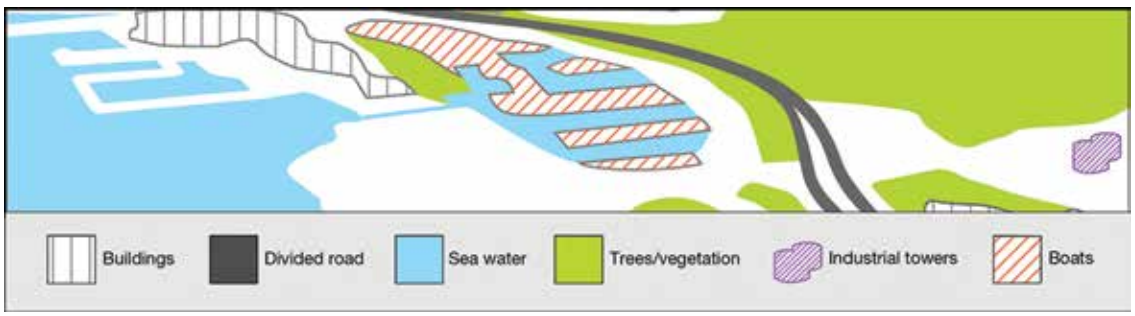
STEP 4

Create a colour coded key/legend for each feature and place it near the map. If you want to use appropriate symbols, choose those too. For example, a red cross might be suitable symbol to represent a hospital. You can add to your key/legend as you go.

STEP 5

Inside the border, draw an outline of the base features of the area, such as rivers, coastlines and major roads. These will guide your colouring.

FIGURE 4 The base features are drawn.



STEP 6

Individually, take each of the features that you have identified and mark onto your base map the approximate area that it covers. When you have completed one feature, colour it before moving to the next feature. This will prevent confusion with colouring other features.

STEP 7

You may wish to label some significant features of the sketch map. Do this neatly and horizontally.

STEP 8

Complete the simplified sketch map with BOLTSS.

eBook*plus*

Interactivity
Constructing a basic sketch map
Searchlight ID: int-3157

8.12.3 Let me do it

Developing my skills

Using the aerial photograph of Darwin shown in figure 2, complete a basic sketch map of the city and its environments.

Questions

1. Describe the natural environment of Darwin. Mention the base features that you used to make your sketch.
2. What type of buildings make up the greatest proportion of the built environment of Darwin?

3. Suggest two reasons for the focus of the city on marine activities.
4. There is vacant land to the right of the coastal road. On your sketch map, shade the land use that might appear here in 20 years' time. Justify your shading using labelling placed on your sketch map.
5. How does this city compare to the place in which you live?

Checklist

I have:

- drawn in pencil
- not tried to show everything in great detail
- used colour with a key/legend
- included BOLTSS.

Skills questions

1. Basic sketch maps are used to show:
   a. detailed information
   b. generalised information
   c. complex information
   d. limited information.
2. A basic sketch map includes information about:
   a. land use
   b. soils
   c. slope
   d. rainfall.
3. Why are basic sketch maps a great tool for geographers?
4. What information can you get from looking at a basic sketch map?

8.14 Review

8.14.1 Review

1. Construct a detailed list of factors (reasons) that influence where people live.
2. a. Why do you think people want to live in remote locations?
   b. Why do you think people are able to live in remote locations these days?
3. What services allow FIFO settlements such as Tom Price to exist?
4. What services and facilities does Docklands have that to allow it to be a 24-hour city for visitors?
5. How might the quality of the ***environment*** differ in the following places: Sydney, Monkey Mia, Byron Bay and Melbourne?

8.14.2 Reflect

6. Refer to the following table.

TABLE 1 Selected crimes in Docklands, 2013/2014

Crime category	Melbourne LGA's rate per 100 000 population	Average rate in Victoria per 100 000 population
Burglary (residential)	474.9	493
Assault	2276	810
Robbery	203	45
Theft from motor vehicle	1550	837
Theft (shopsteal)	1720	359

Source: © Australian Bureau of Statistics.
Note: Docklands is part of the Melbourne local government area (LGA).

   a. Construct a series of column graphs to represent crime statistics in Docklands (Melbourne local government area) and the average for Victoria.
   b. Compare the numbers of crimes in Docklands (Melbourne local government area) with the average for Victoria, as revealed in your graphs.
   c. What might Docklands residents think of how safe it is to live there?
   d. What bias might there be in the statistics?
7. Read the following information and then answer the questions.

> The Docklands Community and Place Plan was launched in July 2012. The community's input combined with detailed planning and design studies have helped shape a range of projects to be delivered in Docklands over the next 10 to 15 years. These projects are ones that Places Victoria and the City of Melbourne are committed to delivering over the next 10 years and beyond.
>
> Projects have been established such as the Docklands Community Garden, which allows residents to interact with one another.
>
> The City of Melbourne, Places Victoria, and the private and public sectors will establish facilities and infrastructure that will create a sense of place in Docklands, including multi-purpose ball courts, a library and community centre, boating hub, and pedestrian improvements.
>
> There is also a Docklands community forum. This is a public meeting held every two months, which allows residents to contribute to the Docklands Community and Place Plan.
>
> *Source:* Adapted from *Docklands Community and Place Plan*

   a. Describe the services and facilities that encourage community interaction and a feeling of connectedness in Docklands.
   b. Which services and facilities in your community give you a feeling of connectedness? What more do you feel could be done in your local community to foster this?



The places people live in around the world have many different characteristics and features.

CHAPTER 9

People and places

9.1 Overview

9.1.1 Introduction

We all live in different places. Places are important to people, whether they are rural or urban, remote or central, permanent or temporary. But no two places are alike; they differ in aspects such as their appearance, size and features. In your mind's eye, try to picture the similarities and the differences between places such as a country town, a popular tourist destination, a remote village overseas, a scientific base in Antarctica, an Indigenous community and a mining town. You may think of others to add to this list.

Starter questions

1. Brainstorm, as a class or individually, a list of other types of ***places*** in which people live around the world.
2. Choose three examples of ***places*** on your list that have been strongly influenced by the quality of the ***environment***. Explain how the ***place*** is influenced by the ***environment***.
3. Other than ***environmental*** qualities, what influences the characteristics of a ***place***?
4. How true is it that 'no two places are the same'? Use images on these pages, or ***places*** you know, to support your opinion.

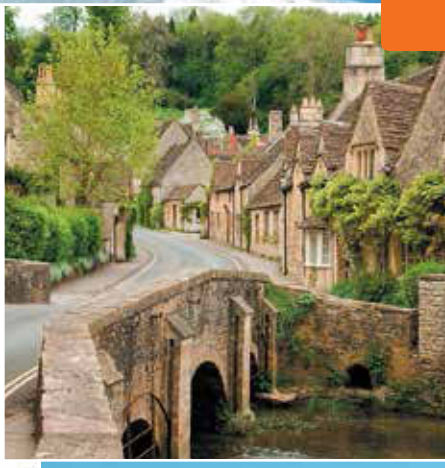
Inquiry sequence

		Syllabus outcomes
9.1 Overview		
9.2 Where do most Australians live?		GE4-1
9.3 SkillBuilder: Understanding satellite images	eBookplus ONLINE ONLY	GE4-7
9.4 SkillBuilder: Using alphanumeric grid references	eBookplus ONLINE ONLY	GE4-7
9.5 Services and facilities important to wellbeing		GE4-1, GE4-3
9.6 How does distance affect lifestyle?		GE4-3, GE4-6
9.7 What is life like in a rural town?		GE4-4
9.8 Environmental quality and liveability	eBookplus ONLINE ONLY	GE4-3
9.9 Investigating topographic maps: What makes Mount Etna a dangerous place to live?		GE4-3, GE4-4, GE4-7, GE4-8
9.10 What influences community identity?		GE4-4, GE4-6
9.11 What are remote settlements like?		GE4-1, GE4-3
9.12 What is Old Delhi like?	eBookplus ONLINE ONLY	GE4-1, GE4-7
9.13 How is modern India changing?	eBookplus ONLINE ONLY	GE4-1, GE4-3
9.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	

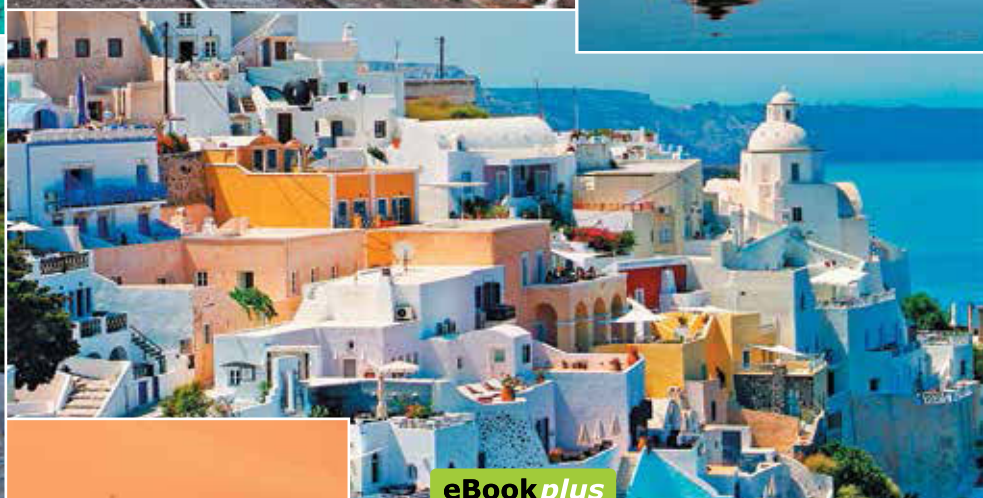










eBook*plus*

Watch this video
Why we live where we do
Searchlight ID: eles-1620

9.2 Where do most Australians live?

9.2.1 Historic settlements and transport networks

Does the availability of rainfall explain why modern Australians live where they do? Could it also be warmer weather, good soils, and access to the coast, mineral resources, people and flat land?

Approximately two-thirds of Australia's population live in capital cities. Australia is a large, dry and isolated country. The availability of fresh water is an important factor to consider when looking at where people live.

Australia's first large European settlements were all built close to rivers and harbours, which provided safe anchorage for their sailing ships. The early settlers and convicts, along with their possessions and food, were all transported from Europe by ship. These settlers were quite wary of the unknown inland of the continent, so they clung to the coast and relied on sea transport. The sea allowed goods to be imported and exported; it provided fishing, whaling and sealing; and it brought cooler weather due to onshore breezes. Rivers, provided water for household, industrial and agricultural use, as well as a safe port for passengers and cargo.

Sydney, Melbourne, Brisbane, Hobart, Adelaide and Perth were generally the first settlements in each colony. They have maintained their importance as their state's largest city and its centre of government, transport and commerce. Big cities are great places to live because they provide many opportunities for work, education, healthcare and recreation.

FOCUS ON FIELDWORK

Looking at and listening to your place

Geographers are particularly interested in:

- the location of things
- the distance between things
- the distribution patterns we can see when we produce a map
- the connection between places and the environment
- the connection between places and the community.

Work in pairs to gather data to complete a sound-map report of *your place*. *Your place* can be the schoolyard, backyard or your local park.

Step 1: Obtain a map or construct a sketch map (see SkillBuilder 8.12 'Creating a sketch map') of your selected place.

Step 2: Label the different land uses in and around your selected place. Include streets, theatres, classrooms, creeks, vegetation and so on.

Step 3: Identify five different locations at *your place*. Mark these places on your map. Take note of the approximate distance between each place. You may want to take a trundle wheel or a GPS with you.

Step 4: Walk to each of the five places and listen to the surrounding sound. You may want to close your eyes to concentrate. At each location, write down the sounds that you can hear. What do you hear first? With added concentration, what other sounds can you hear?

Step 5: Write down all the noises and sounds that you hear. Repeat this step for all of the locations.

Based on the information you have gathered, write a report to describe:

- what you heard at each location
- what created the sound at each location
- what impact the sounds had on your wellbeing
- how the sounds reflect the type of community you live in and your surrounding environment.

Land use

Since 1788, people have changed the natural environment by clearing vegetation and using the land for building cities and farms and creating the services people need.

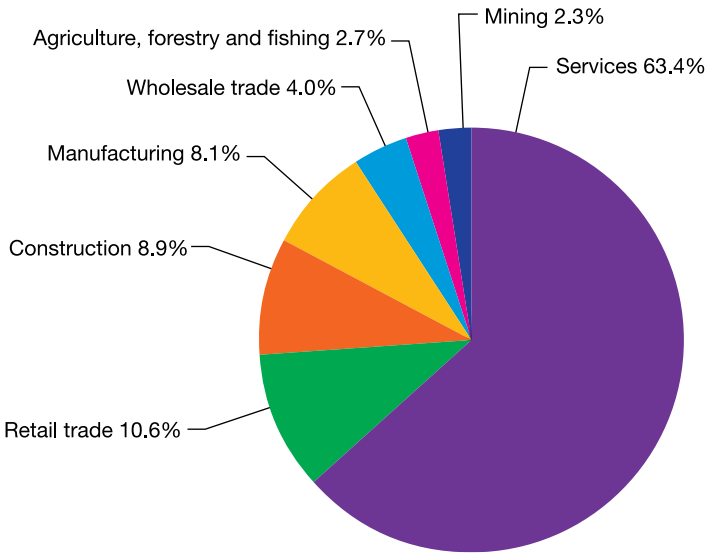
Figure 2 shows the different types of land use in Australia. Climate and soil play a large role in determining how the land is used to grow crops and raise animals.

Extensive land use is where there are large areas of farm land with few workers and not many cows or sheep per hectare.

Intensive land use is where farms are smaller, but have more workers and machinery to produce high yields per hectare; examples are dairy and poultry farms, orchards, vegetables and feedlots. Compare this land use map to a rainfall map in your atlas. Does more rain tend to fall in the intensive or the extensive land use regions?

In places where rainfall is low or unreliable, such as central Australia, grass growth is seasonal. This semi-arid interior does not support the variety of land uses that are possible closer to the coast. Over 80 per cent of Australia's population lives within 500 kilometres of the coast between Brisbane and Adelaide; some are on farms but most are in regional towns and capital cities.

FIGURE 1 Australia's job sectors, 2013

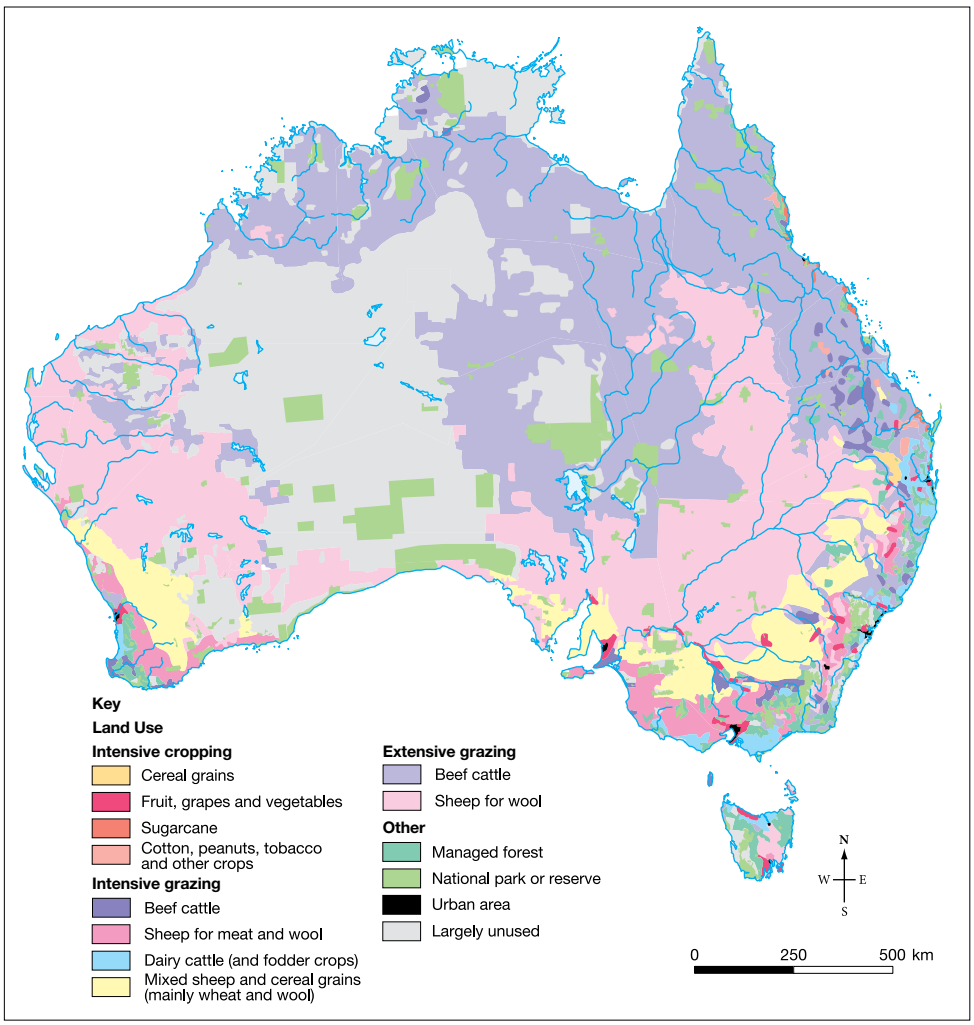


Jobs

People need to work in order to provide for their basic needs. Figure 1 shows that the majority of jobs in 2013 were in the sectors of services (health, finance, education and administration), retail trade and construction. Most of these job opportunities are available in major cities and regional centres, which are generally close to the coast and in areas of higher rainfall.

There are fewer job opportunities in dry and remote regions of Australia. Agriculture and mining provide some chances for employment in these places. Some jobs are also available in manufacturing (processing the output of farms and mines) and in services, such as healthcare and tourism. According to the Australian Bureau of Statistics, 25 per cent of new jobs created in

FIGURE 2 The major land use regions of Australia



Source: MAPgraphics Pty Ltd, Brisbane

the next 10 years will be in the services sector, especially healthcare, but these will mostly be in the cities. Mining jobs in remote places are expected to increase but not by enough to push them above their current two per cent of total employment in Australia. Remote mining sites have skills shortages that require employers to pay very high wages to attract workers.

ACTIVITIES

IDENTIFY

1 State four reasons why the state capital cities were settled.
2 In Australia, are more workers employed in mining or in manufacturing?

EXPLAIN

3 What is the difference between intensive and extensive land use? Give examples of each type.
4 Study a rainfall map of Australia (*Jacaranda Atlas Eighth Edition*, page 40) and the land use map of Australia (figure 2). Approximately how many millimetres of annual rainfall do areas of (a) intensive farming receive and (b) extensive farming receive?
5 Study the human features map of Australia (*Jacaranda Atlas Eighth Edition*, page 45). (a) What are the approximate populations of the capital cities? (b) Why do you think the majority of the population lives there?

APPLY

6 What are the future problems with water use in Australia? Support your answer with statistics.
7 'Water is the main reason to explain where Australians live.' Write a paragraph that agrees with this statement and another that disagrees with this statement.

INVESTIGATE

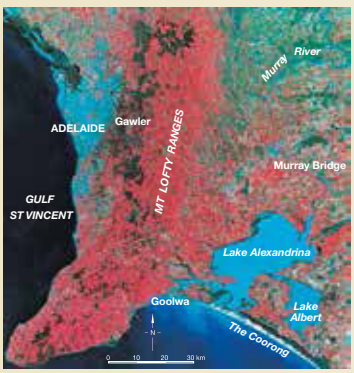
8 What are the future problems with water use in Australia? Support your answer using statistics.
9 Are there regions of intensive agriculture found in ***places*** with much less rainfall? Where are they? What might these farmers do to increase the available water for their crops?

eBook*plus* ONLINE ONLY

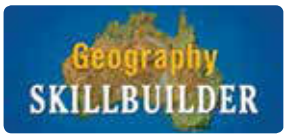
9.3 SkillBuilder: Understanding satellite images

What are satellite images?

Satellite images are images that show parts of our planet from satellites in space and transmitted to stations on Earth. Satellite images help geographers observe a much larger area of the Earth's surface than photographs taken from an aircraft.



eLesson
Watch this video to learn how to understand satellite images.



Searchlight ID: eles-1643

Interactivity
Try this interactivity to learn how to understand satellite images.



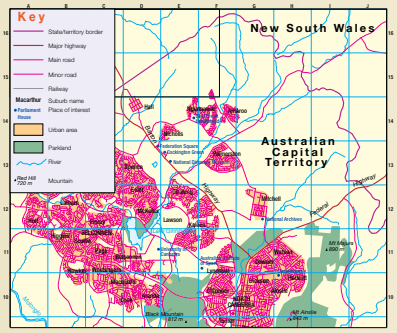
Searchlight ID: int-3139

eBook*plus* ONLINE ONLY

9.4 SkillBuilder: Using alphanumeric grid references

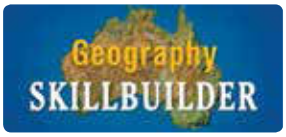
What are alphanumeric grid references?

Alphanumeric grid references are a combination of letters and numbers that help us locate specific positions on a map. Letters and numbers are placed alongside the gridlines, just outside a map. The grid, letters and numbers allow you to pinpoint a place or feature by stating its alphanumeric grid reference.



eLesson

Watch this video to learn how to use alphanumeric grid references.



Searchlight ID: eles-1642

Interactivity

Try this interactivity to learn how to use alphanumeric grid references.



Searchlight ID: int-3138

9.5 Services and facilities important to wellbeing

9.5.1 Services and facilities

Wellbeing refers to a good or satisfactory condition of existence. It includes lots of different aspects of a person's lifestyle such as health, happiness, prosperity and welfare.

Services and facilities are very important to a person's wellbeing. They can impact nearly every part of a person's lifestyle. Services and facilities vary but they provide support and infrastructure to a place as well as contribute to a sense of community.

9.5.2 Transport and roads

The way people get from place to place is important. Whether it is to visit friends, go on holidays or to work, travel (near or far) is an essential part of daily life and wellbeing. Aeroplanes, trains, buses, cars and bikes are examples of the transport used by people to get from place to place.

FIGURE 1 It is important for roadways to be well maintained and safe for people to use.



9.5.3 Education

Having access to quality schools and childcare programs is important to a child's development. Families often choose to live near schools where they would like their child to attend. Playgrounds and parks are also appealing to families.



FIGURE 2 Mountains of waste in New Delhi, India, put people at risk of diseases and illness.



FIGURE 3 Waste collection in Australia

9.5.4 Water

Access to clean water for drinking, washing and bathing prevents lots of transmittable diseases and infections. Access to clean water is readily available in Australia; however, it can be very difficult in other parts of the world. According to the World Health Organization over one billion people do not have access to safe drinking water.

9.5.5 Waste

In Australia, garbage is collected on a weekly or fortnightly basis. It is a service provided by local and state governments to remove waste. This waste can then either be recycled or become landfill. It does not pile up in the cities or suburbs. In New Delhi, waste is piled up on the outskirts of the city. Not only does it cause physical disease and illness, but it also decreases the quality of the air.

Another important service to human wellbeing is sanitation. Human wastes are removed from houses and buildings via sewerage pipes and systems to sewerage facilities, where it is treated to remove harmful materials and then flushed back into the ocean or even used as drinking water.

9.5.6 Healthcare

Health services include medical centres, hospitals, aged care facilities, dentists, optometrists, psychologists, physiotherapists and more. Access to these types of services and facilities allows people to maintain good physical and mental health.

9.5.7 Shopping centres

Shopping centres offer more than retail therapy. They can also offer other services, such as banking, travel agents, dry cleaning or technological repairs, which can contribute to wellbeing.

FIGURE 4 Shopping centres offer lots of convenient services and facilities.



9.5.8 Cafés and restaurants

Cafés and restaurants contribute to a sense of community. They are places where families and friends can meet and dine in a social atmosphere.

9.5.9 Variations in access to services and facilities

Access to services and facilities varies according to where you live. There is a great difference between the services and facilities available in urban, rural and remote areas. There is even more of a contrast in services and facilities between more economically developed and less economically developed countries.

Urban areas have the most access to a wide range of services and facilities. Rural areas and particularly remote areas have less access to a range of services and facilities. Due to the geographic location of these rural and remote communities, it can be difficult to attract enough professionals to service the community.

In Australia, seven of NSW's regional cities have formed the Evocities campaign which aims to attract people (and their qualifications) from the city, with the purpose of increasing the quality of infrastructure, business numbers, facilities, lifestyle and population growth. The Evocities include Albury, Armidale, Bathurst, Dubbo, Orange, Tamworth and Wagga Wagga.

ACTIVITIES

IDENTIFY

1 Define *wellbeing*.
2 Provide a list of services and facilities in your local area.

EXPLAIN

3 Why is healthcare important to wellbeing?
4 What types of services and facilities do shopping centres offer? Try to think of your local shopping centre to assist you.

APPLY

5 What services and facilities do you think your local community is missing?

INVESTIGATE

6 Use the **Evocity** weblink in your eBookPLUS to view the seven evocities.
   a What are the benefits of moving to an Evocity?
   b Which of the Evocities would you move to?
   c Describe the services and facilities in the Evocity you would move to.
   d Explain how the services and facilities contribute to the wellbeing of your selected Evocity.

eBookplus

Weblink
Evocity

9.6 How does distance affect lifestyle?

9.6.1 Travelling for football

People who live in rural areas often have to travel, sometimes over long distances, to access goods, services and social events. While some see this travel as a problem, others believe that the advantages of rural life outweigh any inconvenience.

In **sparsely populated** parts of Australia, there are huge distances between towns. For example, the West Australian Football League runs a talent academy in the north of the state. Boys in the 15- and 16-year age group from the Gascoyne, Broome and Pilbara regions are selected to attend training camps. The camps are held in Broome, Port Hedland, Karratha and Fitzroy Crossing (see figure 1). Some players will travel hundreds of kilometres from their home to a training camp.

sparsely populated describes a region in which few people live

9.6.2 The biggest classroom

For some isolated students, it is not possible to travel to a school every day. Instead, the lessons come to them. The Broken Hill School of the Air has a very big classroom; it serves an area of approximately 250 000 square kilometres, and students can live up to 300 kilometres from the school.

Lessons are provided by satellite, written material, fax, telephone and personal contact. Sometimes several students gather at one location and a teacher will conduct classroom lessons.

Camps are also held so that students can mix with their peers.

FIGURE 1 Major regions in Western Australia



Source: Spatial Vision

FIGURE 2 A game between Yardgee and Bayulu — towns that are approximately 200 kilometres apart in the Kimberley region of Western Australia

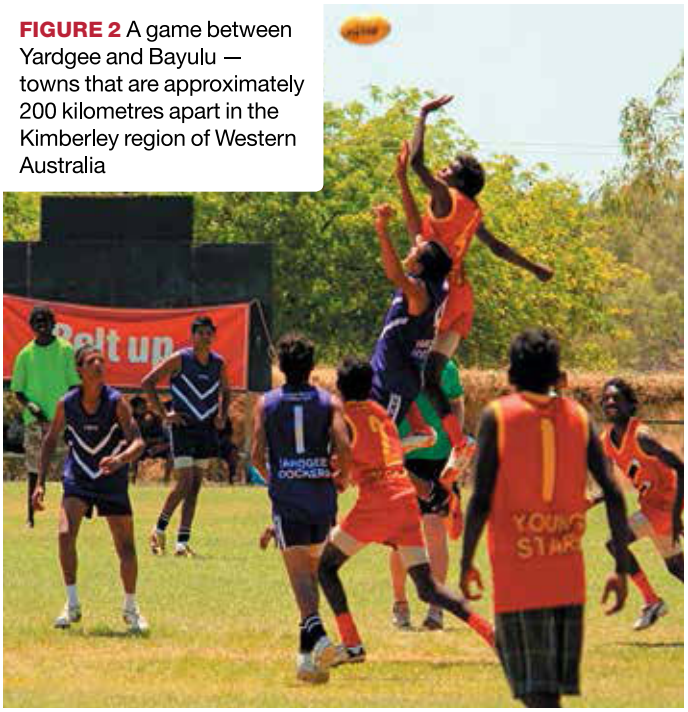


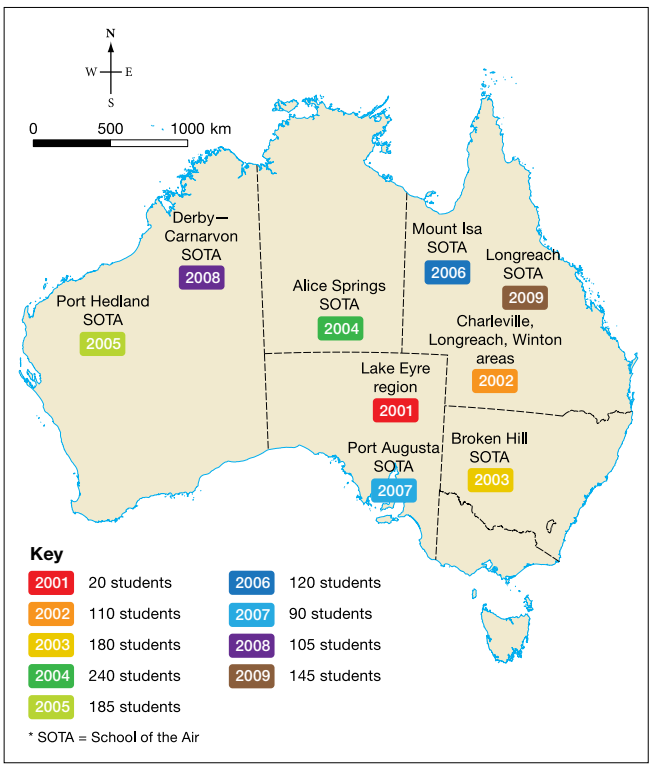
FIGURE 3 School of the air — a lesson conducted by voice and online



9.6.3 Flying scientist

Phil Higgins and his wife Suzanne fly to small schools and outback farms to take science equipment and lessons to students. Sometimes families will gather at a farmhouse for the lessons; at other times the Flying Scientist (nicknamed Phiggles) will visit a rural school. The lessons are so highly regarded that families will drive up to 600 kilometres to attend.

FIGURE 4 Places visited by the Flying Scientist, 2001 to 2010. The Flying Scientist has taken science to children in very isolated places.



Source: Spatial Vision

9.6.4 Shopping

People who live a long way from major towns have always made use of mail order catalogues. Mail order and online goods may take longer to arrive, but the buyers have access to the same goods as anyone who lives in an urban area.

9.6.5 Flying Doctor

The Royal Flying Doctor Service (RFDS) was started in 1928 by the Reverend John Flynn. Its goal is to support those who live in, work in or visit remote areas, and it now deals with about 300 000 patients a year. On any given day, the RFDS might attend to people who have been injured, become unwell or need to be moved to hospital. The service also provides health clinics, immunisation, advice over the phone and education programs.

9.6.6 Other

- *Tertiary study.* There are also a number of university and TAFE college campuses in **regional centres** such as Ballarat, Wagga Wagga, Ipswich, Albany, Alice Springs, Mount Gambier and Burnie.
- *Communication.* There is now mobile phone coverage for 90 per cent of Australia's population. People in very **remote** places can use satellite phones.

regional centre the main town in a region

remote describes a place that is distant from major population centres

ACTIVITIES

IDENTIFY

1 a Refer to figure 4 and identify the states visited by the Flying Scientist in each year from 2001 to 2010.
b Identify how many students attended these classes.

2 Identify two ways in which rural residents buy goods without going to a shop.

3 How can someone access healthcare even though a doctor is hundreds of kilometres away?

EXPLAIN

4 a Describe at least three ways in which life has improved for young people in isolated rural ***places***.
b Explain what you think has had the greatest impact on reducing the disadvantages of isolation.

INVESTIGATE

5 How does the size of the area served by the School of the Air compare to the size of the state in which you live? Your atlas may help.

6 a Refer to figure 1. Measure the distance travelled and the direction travelled by footballers from: Newman to Karratha; Carnarvon to Broome; Paraburdoo to Port Hedland; Kununurra to Port Hedland.
b Take one of the answers to the previous question and work out where you could end up if you travelled that far and in that direction from your home.

PREDICT

7 Think about the following statement: 'As the internet is used for more and more things, people in isolated ***places*** will have the same access to goods and services as those in the cities.' Organise your thoughts under the headings of Yes, No and Maybe.

APPLY

8 Gather data from your class or school to find out how far students travel to reach your school. Produce a map to show the area from which students are drawn.

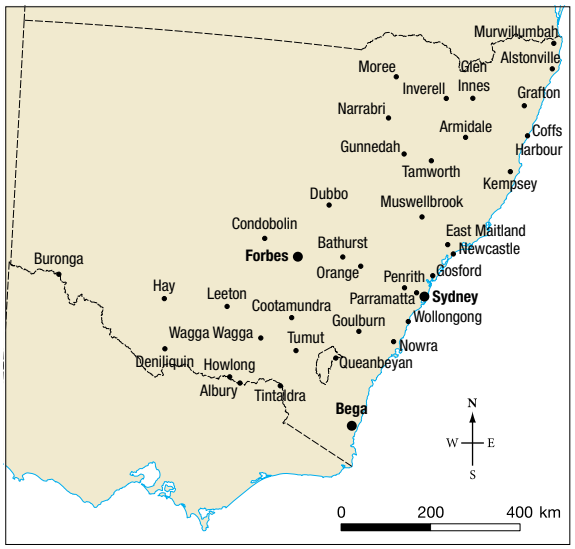
9.7 What is life like in a rural town?

9.7.1 The attraction of the country

Country towns come in all shapes and sizes. They can be small centres with a post office and general store or they can be substantial towns. Living in a country town can be very different to living in a city.

Even though most Australians live in large urban centres, the rural or country regions are very important because this is where food is grown, water is sourced, natural resources are extracted and ecosystems can flourish. Many Australians travel to country places for holidays and many dream of moving to the country. The attractions of country places include cheaper housing, less traffic and a greater sense of safety.

FIGURE 1 Map of New South Wales



Source: Spatial Vision

9.7.2 Demography

The demographic characteristics of country places are influenced by location and activities in the surrounding area.

For instance, Forbes is located approximately 380 kilometres from Sydney. It receives regular rainfall and has fertile soil. It is part of the NSW wheat belt, producing large quantities of wheat and cereal crops. This is the largest employment sector in the town.

Another town, Bega, is located approximately 421 kilometres south of Sydney. It has moderate temperatures and high annual rainfall. The dairy industry is the dominant source of employment. Bega is most renowned for its cheese factory.

GEOskills TOOLBOX

Population pyramids

Population pyramids, or population profiles, show the age and gender of a population. The left side of the pyramid represents the male population and the right side of the pyramid represents the female population. As you can see, the pyramid is separated into age brackets. Each age bracket represents a percentage of the population who are male or female.

At right is an example of the population pyramid for Sydney, 2013.

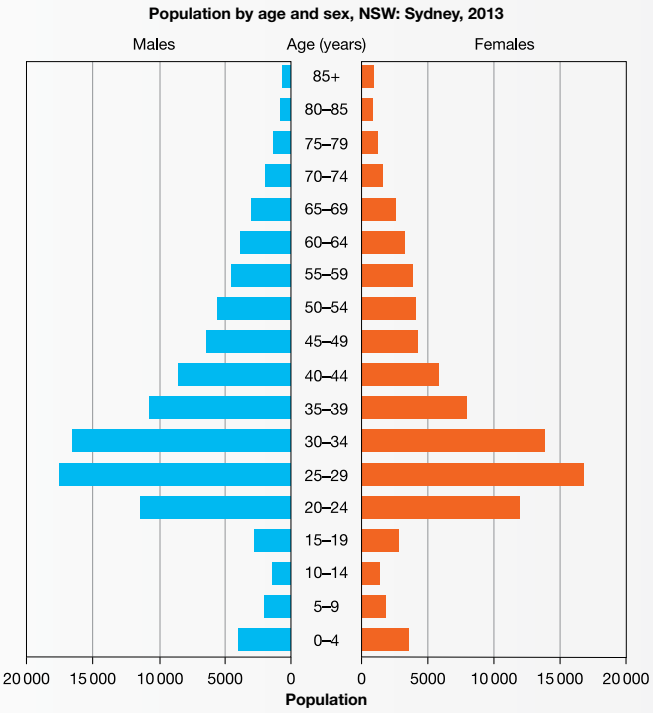


FIGURE 2 Population pyramid for Sydney, NSW (2013)

9.7.3 A sense of belonging

In the country there are opportunities to be involved in a wide range of community activities. Activities might have an economic focus (such as fundraising), an environmental focus (such as Landcare) or a social focus (such as youth groups). A common outcome of all activities is the way they contribute to a sense of connectedness or belonging.

All towns, whether large or small, offer different ways people can become involved in the community. Sport is a popular choice for people to be active and it is also an opportunity to meet new people. Sports offered in a small town like Forbes include: rugby union, soccer, netball, tennis, basketball, swimming and dragon boating. Cultural and entertainment activities, such as brass bands, dance groups, museums and galleries, are also available.

TABLE 1 Population projection data for Bega and Sydney

Age	Bega	Sydney
0–4	1 596	7 750
5–19	5 885	12 953
20–29	2 501	59 021
30–39	2 810	50 944
40–49	3 951	25 656
50–59	5 851	18 435
60–69	5 510	13 349
70–79	3 442	6 606
80 and over	1 885	3 655
Population (2014)	33 431	193 366



FIGURE 3 Forbes' annual camel race is held on Good Friday.

ACTIVITIES

IDENTIFY

1 In which direction would you travel from Bega to reach Sydney? In which direction would you travel from Forbes to Sydney?
2 Identify three reasons why country ***places*** are important.

EXPLAIN

3 Work with a partner to create a list of social, economic and ***environmental*** characteristics of a country town.
4 What are three opportunities in your community for young people to feel socially connected?

INVESTIGATE

5 Study the 2013 data in the population pyramid in figure 2.
   a What percentage of the population is in your age group?
   b What percentage of the population is in your parents' age group?
   c What percentage of the population is in your grandparents' age group?
   d Describe the overall shape of the population pyramid.
   e Based on its population pyramid, what issues could Sydney face in the future?
6 Indigenous Australians have always had a sense of belonging to a ***place***, and elements of the natural ***environment*** are honoured on their flags. Find out what the Aboriginal flag and the Torres Strait Islander flag look like. What aspects of the natural ***environment*** are represented on each of these flags?
7 As a class or group, brainstorm the meaning of the term *country life*. Construct a list of words that describe your agreed view. Find images to represent your words and create a collage to represent rural living.
8 Create a class list of country towns that you know. Locate these on a map and, for each town, provide the following information about its location: latitude, distance and direction from the state capital city, and distance and direction to a natural feature. Refer to an atlas. Find out about the services the towns offer.

APPLY

9 In Australia, the trend is for people to move away from the country to the major cities. Suggest three reasons why you think this happens.

eBook*plus*

Interactivity
Country town services
Use this interactivity to analyse the services found in Leongatha. Classify them as to whether they would appeal to people aged under 18 or to people 60 and over.
Searchlight ID: int-3092

eBook*plus* ONLINE ONLY

9.8 Environmental quality and liveability

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

9.9 What makes Mount Etna a dangerous place to live?

9.9.1 Natural hazards

Natural hazards threaten the environmental quality and in turn the liveability of a place. The risks associated with natural hazards are potentially very dangerous to people. The risks include destruction of housing, infrastructure, environments and loss of life.

A natural hazard refers to the risk of a natural event which has the potential to cause catastrophic damage to both physical and human environments. Drought, floods, tropical storms, cyclones, volcanoes, fires, tsunamis, earthquakes and landslides are all examples of natural hazards. The actual destruction of the landscape due to a natural hazard is called a natural disaster. The risk of natural hazards and previous natural disasters reduce the environmental quality of a place.

9.9.2 Mount Etna, Italy

Mount Etna is Europe's most active volcano. It is approximately 3323 metres high and situated on the island of Sicily, Italy (37°N, 15°E). The slopes of Mount Etna are home to 5 million people (25 per cent of the island's population). Figure 1 shows Mount Etna in the background and the city of Catania in the foreground. The city of Catania is located only 35 kilometres from Mount Etna.

Why is Mount Etna dangerous?

Mount Etna poses a direct threat to the populations living on its slopes — it is a very active volcano! To improve the liveability and to decrease the threats to the population, Italian authorities have tried several methods, including dams and channels, to redirect lava flows away from the communities.

ACTIVITIES

For all of the activities, refer to figure 2, a topographic map extract of Mount Etna, Italy.

IDENTIFY

1 State the altitude of Mount Etna.
2 Write the scale of the map as a ratio.
3 State the contour interval of the map.
4 What are the two types of vegetation that surround Mount Etna?
5 Which direction was the photographer facing when they took figure 1?
6 Describe the contour pattern of Mount Etna.
7 Describe the location of the highway.
8 Give the area reference for the following locations:
  a Misterbianco
  b Acireale
  c Bronte.
9 Give the grid reference for the following locations:
  a Mount (Monte) Piniteddu
  b spot height 1316 to the east of Bronte
  c where the highway crosses the railway in the south-east quadrant.

EXPLAIN

10 Describe, using evidence, the types of transport people use to connect with other ***places***.
11 Explain how the transport routes improve the connectedness between ***places***.

PREDICT

12 a If Mount Etna erupted, which ***places*** would be affected by the lava flow?
  b What would be the predicted impact to the nearby towns?
  c What would be the potential ***environmental*** impacts of this?
  d How could people plan to protect their homes from lava flow?

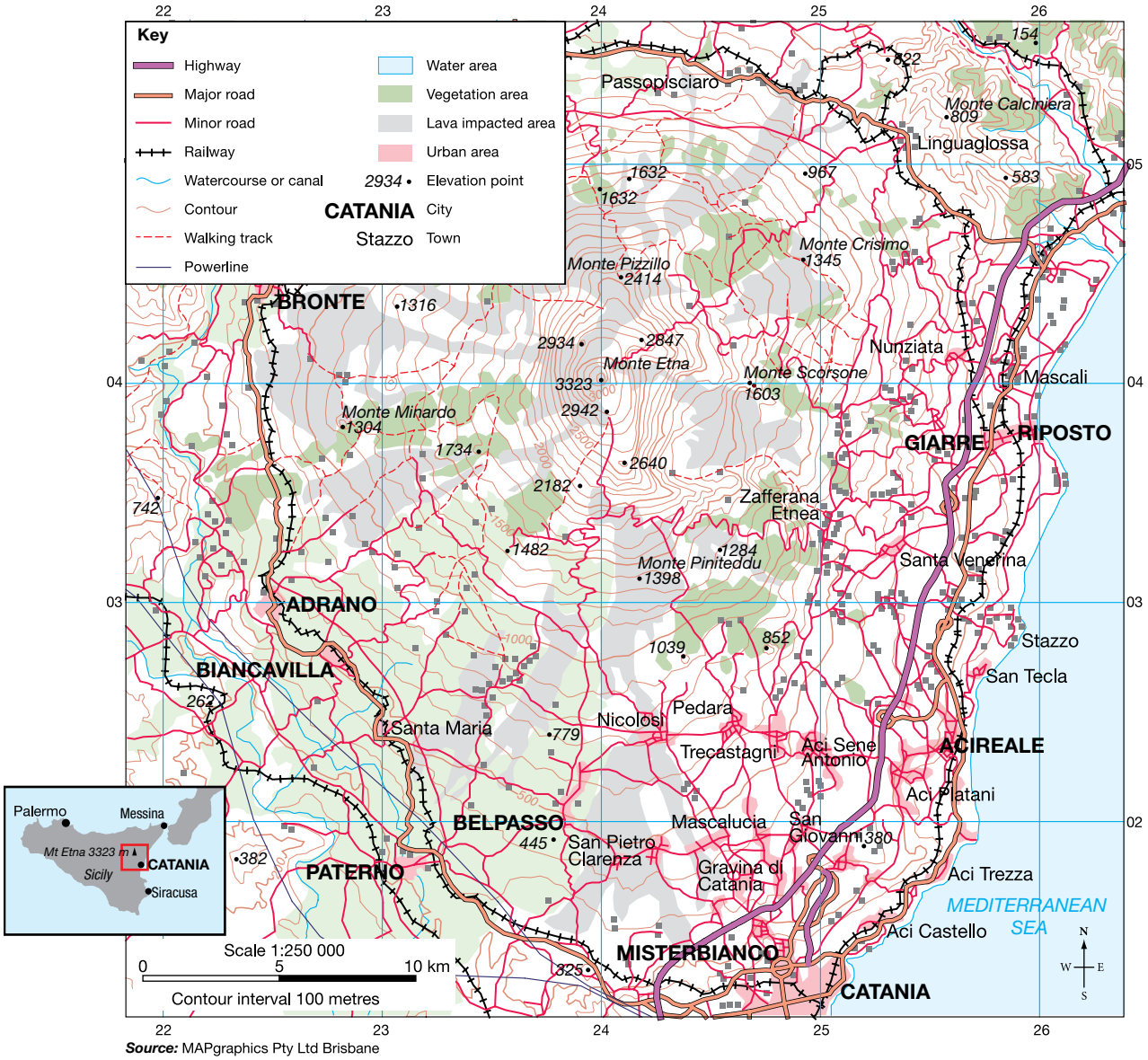
INVESTIGATE

13 When was Mount Etna's latest eruption?
14 Where do you think the safest ***place*** to live in Australia would be and why?

FIGURE 1 Mount Etna



FIGURE 2 Topographic map extract of Mount Etna



Source: MAPgraphics Pty Ltd Brisbane

9.10 What influences community identity?

9.10.1 Culture

A community shares a common interest or location. Communities connect face-to-face and increasingly via electronic devices.

Community identity is closely linked to culture. There are many different aspects of culture such as clothing, family heritage, language, food, music, dance and architecture. All of these elements influence the way in which communities express, celebrate and share their culture. These elements also become symbols of a culture.



FIGURE 1 A lion dance performed in Foshan City, China, to celebrate Chinese New Year. These dances bring good luck for the year ahead.

9.10.2 Environment

The physical and human environment reflects the values of the community. The ways in which the environment is displayed, developed and connected influence how it is perceived. The abundance or lack of features can shape the way people utilise or appreciate a space. For example, a green area with lots of grass and trees would be used very differently to an area with high-density buildings in a business district.

9.10.3 Public events

Public events and festivals are important ways for a community to express and share their values. It is also how community groups grow in numbers — especially communities who connect over a common interest. The RSPCA is an independent community-based charity; its aim is to prevent animal cruelty and promote the humane treatment of animals. They are also reliant on volunteers to be involved in animal shelters and to run the adoption program. In May every year, they have their major fundraiser, the Million Paws Walk, where pet owners and their pets walk to raise money to support the RSPCA programs. The walk attracts over 80 000 people and 45 000 pets each year. It is considered to be a huge success in meeting their aim as a community group who supports animal rights.



FIGURE 2 The RSPCA's annual fundraiser, the Million Paws Walk, around Albert Park Lake in Melbourne 2015.

9.10.4 Religious beliefs

Religious architecture and celebrations are noticeable features amongst a community. Temples, churches, mosques and synagogues are often elaborate buildings where members of the community can practise their faith. For example, the Blue Mosque (figure 3) in Istanbul, Turkey, is a prominent feature of the cityscape. Saint Basil's Cathedral (figure 4) in Moscow, Russia, is an important place of worship to the Catholic community.

FIGURE 3 The Blue Mosque is one of the many mosques within Istanbul, Turkey, where Muslims can practise their religion.



FIGURE 4 Saint Basil's Cathedral in Moscow, Russia, is an important place of worship for the local Catholic community as well as travelling tourists.

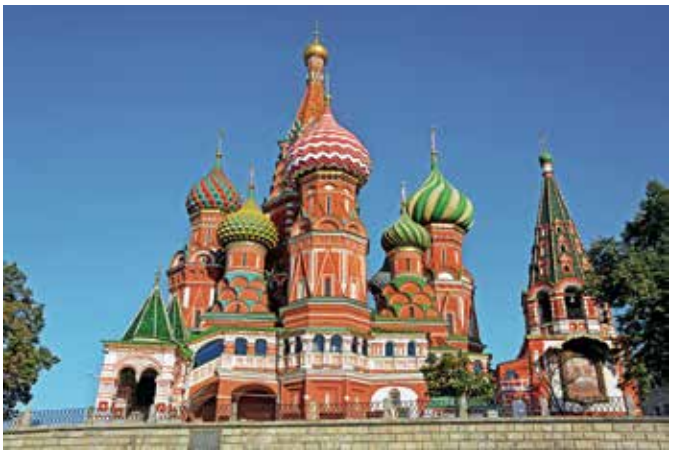


FIGURE 5 The changes in the types of technologies used around the world

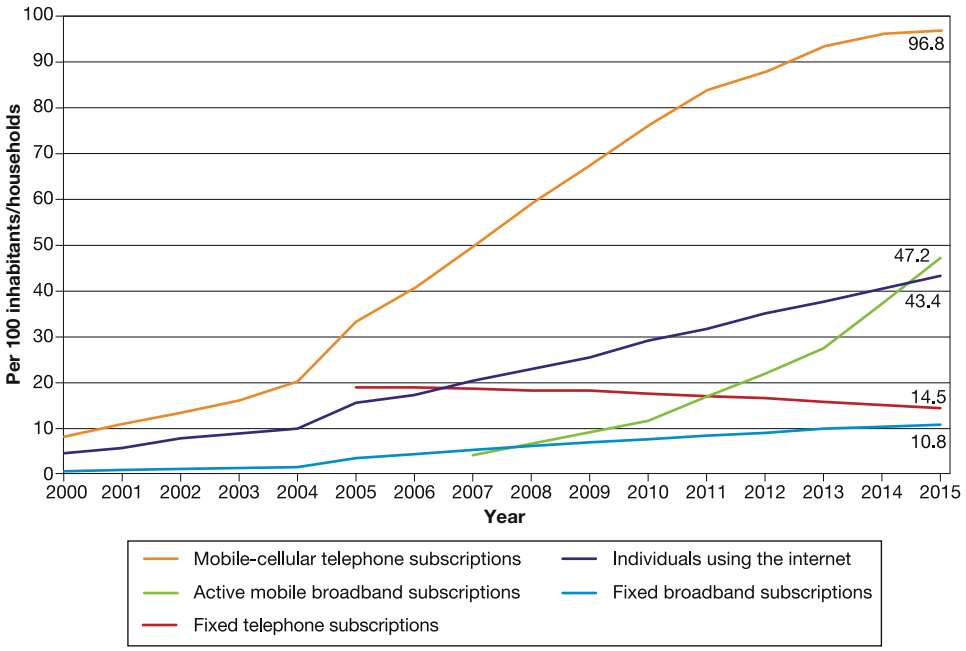


FIGURE 6 Some of the various technologies that have changed the way we interact and communicate with other people



9.10.5 Factors that enhance connectedness

Technology

In all of its forms, technology is bringing people closer together. For example, the development in aviation technology allows people to meet in person; but, even more so, advancements in information and communication technology (ICT) allow people to interact online via email, social media and gaming networks. The National Broadband Network (NBN) is being installed across Australia to allow fast and reliable internet connectivity. Wireless communications and mobile technology have dramatically changed the way people access, store and transfer information.

Transport

The movement of people within and between neighbourhoods is an important issue in towns and cities. The bicycle is now seen as a way of increasing mobility, reducing traffic congestion, reducing air pollution and boosting health. Bicycle tracks encourage recreational riding for all ages and dedicated bicycle paths along main routes encourage people to commute by bicycle, rather than car, to work and school.

FIGURE 7 Special bicycle lanes, marked in red, increase the safety of bike riding in urban areas.



Open spaces

Open spaces, also known as parks and green places, contribute to the atmosphere and attractiveness of a community. These can include: foreshore reserves, botanical gardens, dog parks and pocket parks. Open spaces need to be well maintained and have an appeal to the general public. Quality open spaces become attractive for people to use as venues for meditation, exercise, barbeques, picnics and even weddings.

FIGURE 8 Centennial Parklands in Sydney, NSW, is an open space for recreational activities.



ACTIVITIES

IDENTIFY

1 Define culture.
2 State the types of technology you use on a daily basis.
3 Refer to figure 5 to answer the following questions:
   a How many people had mobile phone subscriptions in 2015?
   b What is the difference between individuals using the internet in 2001 compared to 2015?
   c What is the approximate percentage of people who had fixed (wired) broadband subscriptions in 2015?
4 Use information from figure 5 to explain how technology has changed the way people connect with each other.

EXPLAIN

5 Explain how public events shape community identity.
6 Describe reasons why religion and religious celebrations are such an important part to identity.
7 Why are open spaces considered to be such an important part of community identity?
8 Provide an explanation of how you use technology to connect with other people.

APPLY

9 Create a picture collage of a community of which you are a member. Focus on culture, environment, public events and religion (if applicable).

PREDICT

10 How can community identity change over time?
11 How can communities adapt to change?
12 When did fixed telephone subscriptions decline? Provide reasons why this might have happened.

9.11 What are remote settlements like?

9.11.1 Way up north

Life in some towns is strongly influenced by geography. It is now possible to live in extreme conditions and be socially connected while enjoying access to a wide range of goods, services and community activities.

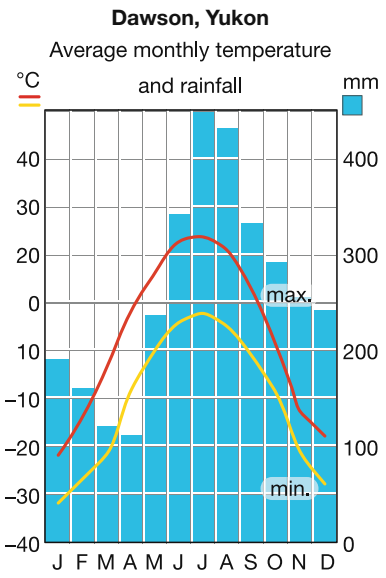
FIGURE 1 Location of Dawson, Yukon, Canada



Source: Spatial Vision

Dawson, with a population of 2000, is the second-largest city in the Canadian state of Yukon. At the latitude of 64°N, it is only about 360 kilometres from the Arctic Circle.

FIGURE 2 Climate graph, Dawson



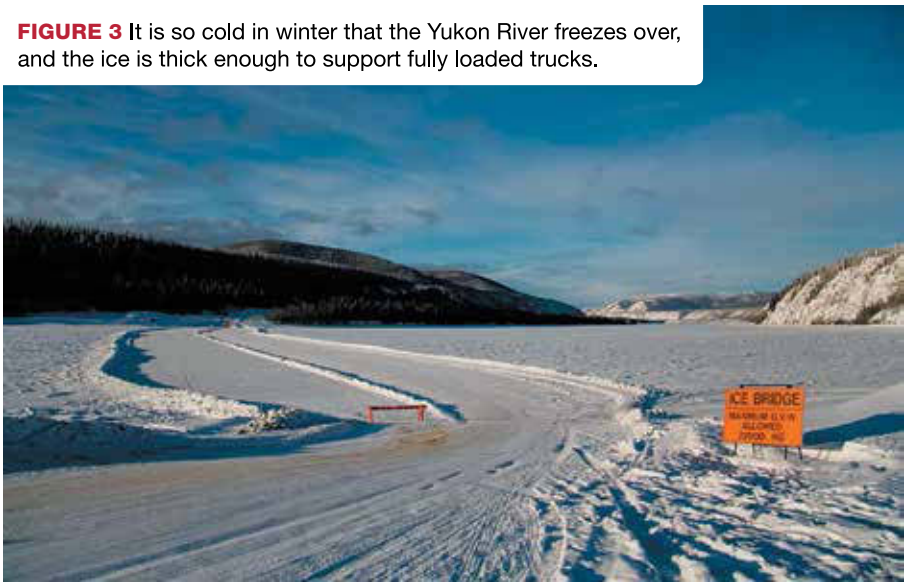
Dawson is a long way from neighbouring towns. It is 770 kilometres from the next town to its north (Inuvik) and 810 kilometres from Anchorage, the largest town in Alaska.

9.11.2 Climate

TABLE 1 Average hours of sunlight at Dawson, Yukon, and Longreach, Queensland

Month	Dawson, latitude 64°N	Longreach, latitude 23°S
January	5.5	13
February	8.5	13
March	12.0	12
April	15.0	12
May	18.0	11
June	21.0	11
July	20.0	11
August	16.5	11
September	13.0	12
October	10.0	13
November	7.5	13
December	4.5	14

FIGURE 3 It is so cold in winter that the Yukon River freezes over, and the ice is thick enough to support fully loaded trucks.



Settlement

The site of Dawson, on the junction of the Yukon and Klondike rivers, was always an important hunting and meeting site for indigenous people, who still live in the area. The harsh climate deterred white settlers from the area until gold was discovered in 1896. The population grew by thousands every week, quickly reaching 30 000.

However, most people did not stay long. Living conditions were very poor: people lived in tents and huts; they had no power, water or sewerage; and crops would not grow in the low temperatures. The **permafrost** also made it difficult to dig the foundations for buildings. Furthermore, it turned out that the gold was not accessible: it was in gravel that was frozen for most of the year.

permafrost a layer beneath the surface of the soil where the ground is permanently frozen

Today

Today the town has **infrastructure**, and housing is solid and heated. The community of Dawson operates year round, with the climate having a strong influence on activities. A road to Alaska has encouraged tourism, and new mining techniques have increased goldmining.

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communication systems, water and power lines

The weather conditions mean that some jobs, such as road-making and building, cannot be done in the winter. Some of those employed in these industries move south in the winter, either for work or holidays.

The town of Dawson is no longer completely isolated in winter. Internet and phone connections allow communication; snow-ploughing and spreading of sand keep the roads open most of the time; and planes fly in and out all year.

The weather influences many aspects of social life in Dawson. The 'Thaw di Gras' carnival celebrates the end of winter, and music festivals and a kayak marathon take place in summer. Winter is the time

of snowmobile treks, skiing and the famous Yukon Quest dog-sled race from Whitehorse (Yukon) to Fairbanks (Alaska). During the race, dogs and mushers (sled drivers) need protection from the cold, but if the weather warms to minus 4°C, it becomes too hot for the dogs to travel during the day.

ACTIVITIES

IDENTIFY

1 Refer to the map in figure 1. How far is Dawson from Whitehorse, the state capital?

2 a What influenced indigenous people to live in the Dawson area?
b Why did people move to Dawson in 1897?
c What influences people to live in Dawson nowadays?

EXPLAIN

3 List at least four ways in which the natural ***environment*** has influenced the settlement of this area.

4 What factors have improved liveability in Dawson?

5 a Construct a multiple bar or column graph to show the average number of hours of sunlight at Dawson and Longreach. (See SkillBuilder 15.6 'Creating a simple column or bar graph'.)
b On your graph, use colour, shading or symbols to show summer and winter at each location.
c Write one statement that is true for both Dawson and Longreach about their hours of sunlight.
d Imagine you live in Dawson, where the school year is from August to June. In which months would you arrive or leave in the dark?

6 Activities in Dawson include volleyball, curling, film festivals, craft, dances, motorcycle riding, gold panning, softball, writing workshops and outhouse races. Which of these would occur only in summer? Which would occur only in winter? Which could occur all year?

INVESTIGATE

7 Use the **Bureau of Meteorology** weblink in your eBookPLUS to find the average monthly temperatures for your location. Present the statistics for the minimum and maximum temperature in a graph (see SkillBuilder 10.4 'Drawing a climate graph'). Compare your graph to the one provided for Dawson. Write three clear statements comparing the average monthly temperatures of Dawson and your location. Write three clear statements comparing the monthly rainfall for Dawson and your location.

PREDICT

8 Which months of the year would be most popular for tourists visiting Dawson City? Provide at least two reasons to support your answer.

9 How do you think the climate would make school life in Dawson different from your life?

APPLY

10 What do you think happened to the early buildings when the heating from houses warmed the soil and melted the permafrost?

11 How have people tried to overcome the disadvantages of this location?

eBookplus
Weblink
Bureau of Meteorology

eBookplus ONLINE ONLY

9.12 What is Old Delhi like?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

9.13 How is modern India changing?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

9.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

9.3 SkillBuilder: Understanding satellite images

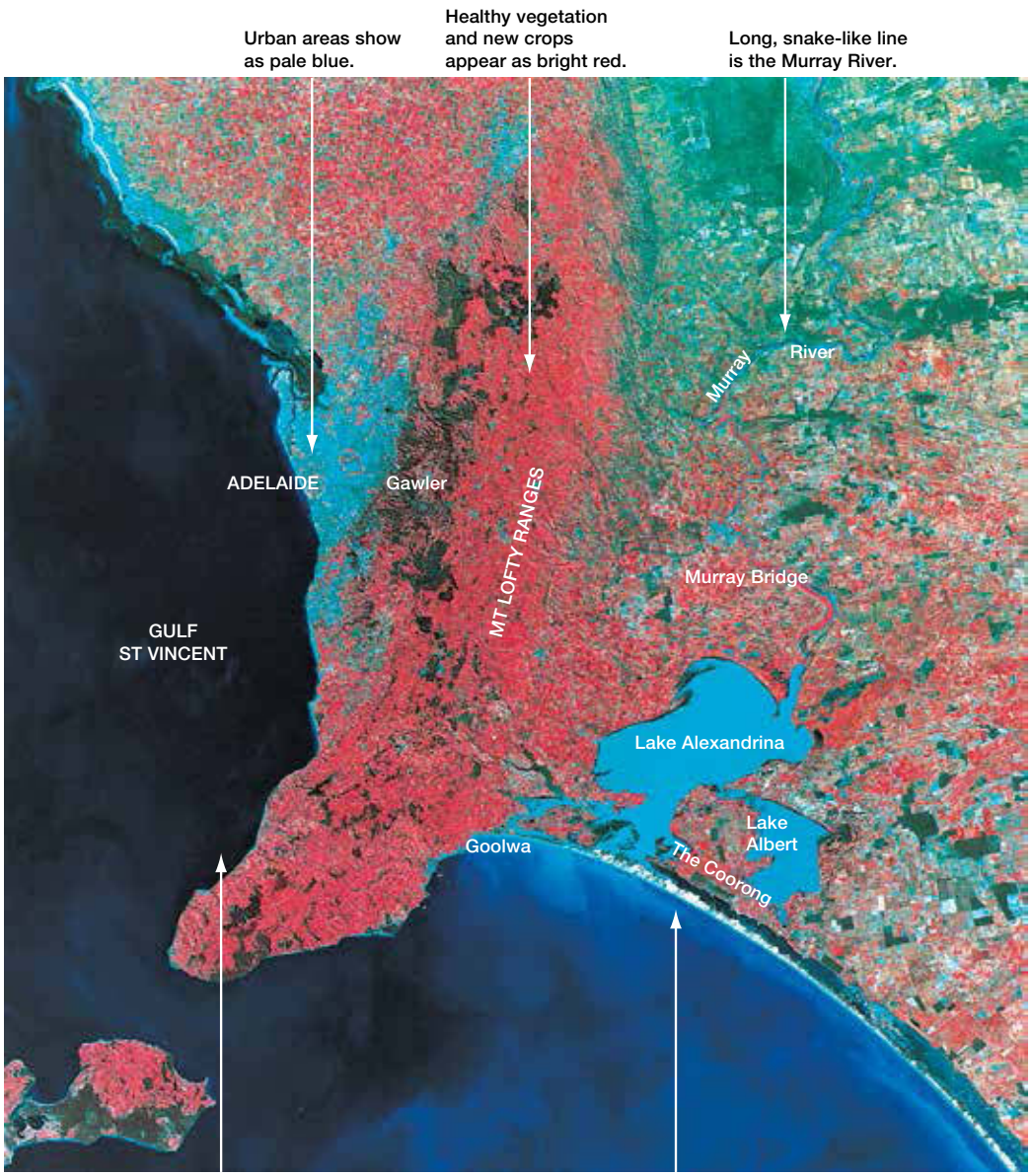
9.3.1 Tell me

What are satellite images?

Satellite images are images that show parts of our planet from space. They are taken from satellites and transmitted to stations on Earth. Satellites can collect a variety of data, including standard photographic imagery, colour infra-red and radar data. They can show Earth in close-up or from far away. Special computer techniques allow data from satellites to be used to highlight patterns on the Earth's surface.

The most common type of satellite image comes from Landsat satellites. They are positioned 700 kilometres above the ground, orbiting the Earth every 100 minutes, and they use special cameras

FIGURE 1 A false-colour satellite image of the Mt Lofty Ranges



Source: © Commonwealth of Australia. Geoscience Australia 1982.

to detect variations in the light reflected from features on Earth. The process of detecting and recording the reflection of light is known as remote sensing.

Why are satellite images useful?

Satellite images help geographers observe a much larger area of the Earth's surface than photographs taken from an aircraft. They can also provide data relatively quickly, so they are often used to monitor natural disasters, including cyclone activity, bushfires and floods. Digital information from satellites is beamed to stations on Earth as radar or microwave signals. Computers are then used to enhance the images, which enable the study of landforms, farmland, disasters, environmental change, weather patterns and even military targets.

Model

Different features can be highlighted in satellite images by selecting only certain bands of light reflected from Earth. These bands of light are assigned false colours to help reveal spatial patterns more clearly. In figure 1, showing the Mt Lofty Ranges in South Australia, the labels point out the patterns.

9.3.2 Show me

How to interpret a satellite image

You will need:

- a satellite image.

eBook*plus*

eLesson
Understanding satellite images
Searchlight ID: eles-1643

FIGURE 2 Satellite image of Canberra, by GeoEye, 26 September 2011



Source: ©2016 Digital Globe

Procedure:

When you look at images taken from above, including satellite images, it can be confusing but you can improve with practice. The following steps can help you to systematically gather the most information you can from images. It is easier if you consider an image of a familiar place, but geographers are also interested in unfamiliar places.

STEP 1

Read the title and check for the date the image was taken. Read any accompanying information.

STEP 2

Identify the main features of the image. What stands out? For example, roads will appear as continuous lines intersected by other lines. Rivers tend to be snake-like, and sometimes you notice trees lining the riverbanks. Dwellings have rectangular roofs and are often clustered together.

This image of Canberra is centred on new Parliament House, although the prominent central flag mast does not stand out. There appear to be wide circular roads and, if you can zoom in, cars are visible.

STEP 3

Look for and label the biophysical features. For example, the black area is Lake Burley Griffin. Green vegetation in a city might be planted or it might be remnant vegetation. Look at the patterns of green to make predictions. Remnant (or remaining) vegetation will often be in an irregular pattern, whereas planted vegetation may be in rows.

STEP 4

Look for and label the built features, such as roads, bridges, sports stadiums and residential housing. Again, look at patterns. Areas of small roofs with road access and surrounding vegetation suggest detached residential housing.

STEP 5

Some colours, patterns and shapes may still be puzzling. Obtain a map of the same area — try an atlas or street directory, Google Maps, Bing or Nearmap. Find names of key features to use in your description. If the features you have identified are shown on the map, check whether your analysis so far matches the map. Use the map to investigate the aspects that are still puzzling. Be aware that the image may have been taken at a different date from the date the map was produced; this might explain other differences in what you see.

eBook*plus*

Interactivity
Understanding satellite images
Searchlight ID: int-3139

FIGURE 3 Satellite image of Currumbin on Australia's Gold Coast, 8 May 2000



Source: Satellite image courtesy of GeoEye. Copyright 2009. All rights reserved

9.3.3 Let me do it

Developing my skills

If you have ever holidayed at the Gold Coast, you may have visited the Currumbin Wildlife Sanctuary. In figure 3, Currumbin generally has more natural vegetation than much of the Gold Coast, partly because it is more difficult to build on the steep hills there, and partly because the forests are valued as wildlife habitat. Currumbin is a popular surf beach and holiday destination.

Questions

Using the image of Currumbin, answer the following questions.

1. Look carefully at the satellite image and make a list of features you can recognise.
2. Find the bridge that crosses Currumbin Creek. Are there any cars on the bridge?
3. What impact have visitors had on the plant life behind the beach?
4. Go to Google Maps and zoom in to Currumbin Beach, Queensland, to find a map of the area shown in figure 3. Turn the satellite layer on. What changes can you see?
5. Suggest how the biophysical features and topography have influenced the settlement pattern in this area.

Checklist

I have:

- checked the title
- identified biophysical and built features
- compared the satellite image with another map to check my interpretation.

Skills questions

1. Satellite images are used to show:
   a. a bird's-eye view of the Earth
   b. the contours of an area
   c. how difficult it is to walk in an area
   d. prevailing winds.
2. The Landsat satellite orbits the Earth:
   a. once a day
   b. every 100 minutes
   c. every four hours
   d. twice a week.
3. What are three types of imagery that can be collected using satellites?
4. Outline two advantages of satellite images.

9.4 SkillBuilder: Using alphanumeric grid references

9.4.1 Tell me

What are alphanumeric grid references?

Alphanumeric grid references are a combination of letters and numbers that help us locate specific positions on a map. They are linked to the lines that form a grid over certain kinds of maps. The letters and numbers are placed alongside the gridlines, just outside the map. The grid, letters and numbers allow you to pinpoint a place or feature by stating its alphanumeric grid reference.

Why are alphanumeric grid references useful?

If it weren't for grid references, finding places in detailed books of maps such as street directories and atlases would be very time consuming. Grid references allow the user to quickly locate the information they want among the hundreds of other features shown on a map. They also allow people to communicate with one another about location when they are using the same map.

Model

FIGURE 1 A section of the Melbourne CBD



Source: Russell Tate / Getty Images Australia

eBookplus

eLesson
Using alphanumeric grid references
Searchlight ID: eles-1642

9.4.2 Show me

How to use alphanumeric grid references

You will need:

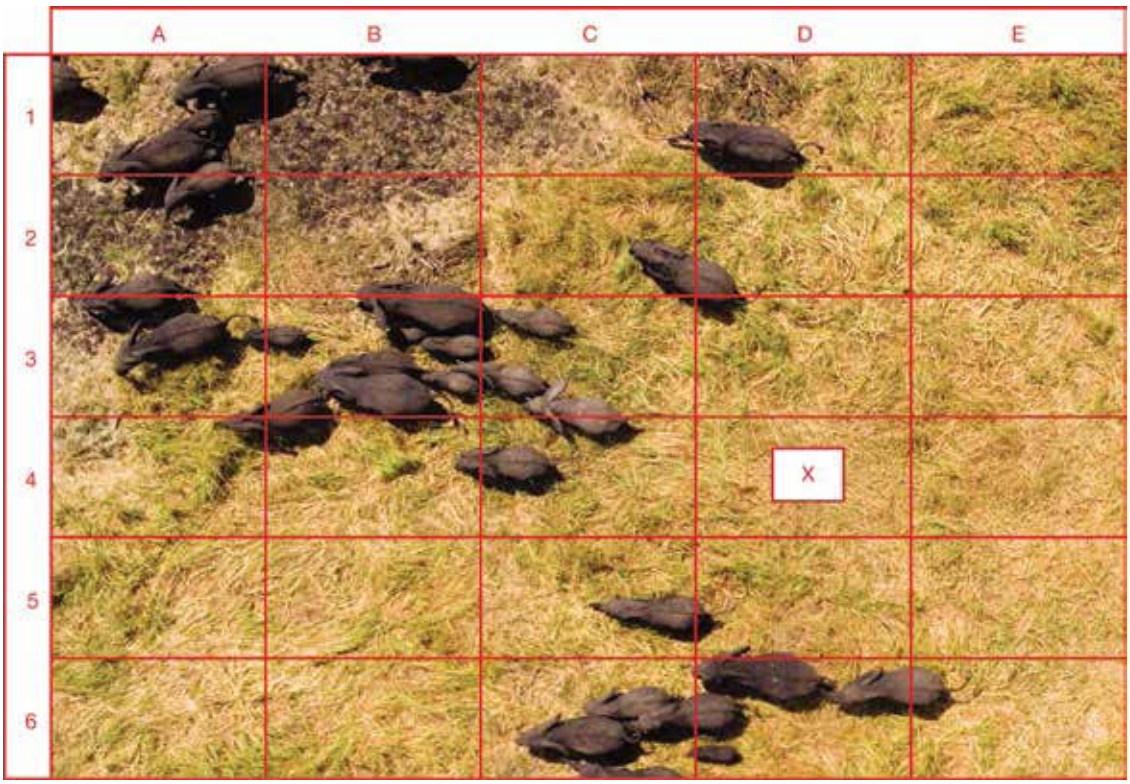
- a map that has alphanumeric grid references, such as a street directory
- a ruler.

Procedure:

STEP 1

Practise with the photo in figure 2 first. In this aerial photograph of elephants in Botswana, we want to locate the veterinarian, Jessica, who is at point X.

FIGURE 2 Aerial photo of elephants in Botswana



STEP 2

Place your finger in the grid square that contains the X. By running your finger up the column of squares, you can see that Jessica is in column D, and by running your finger across the row of squares, you can see that she is in row 4. Therefore, the grid reference for Jessica's location is D4.

eBookplus

Interactivity
Using alphanumeric grid references
Searchlight ID: int-3138

STEP 3

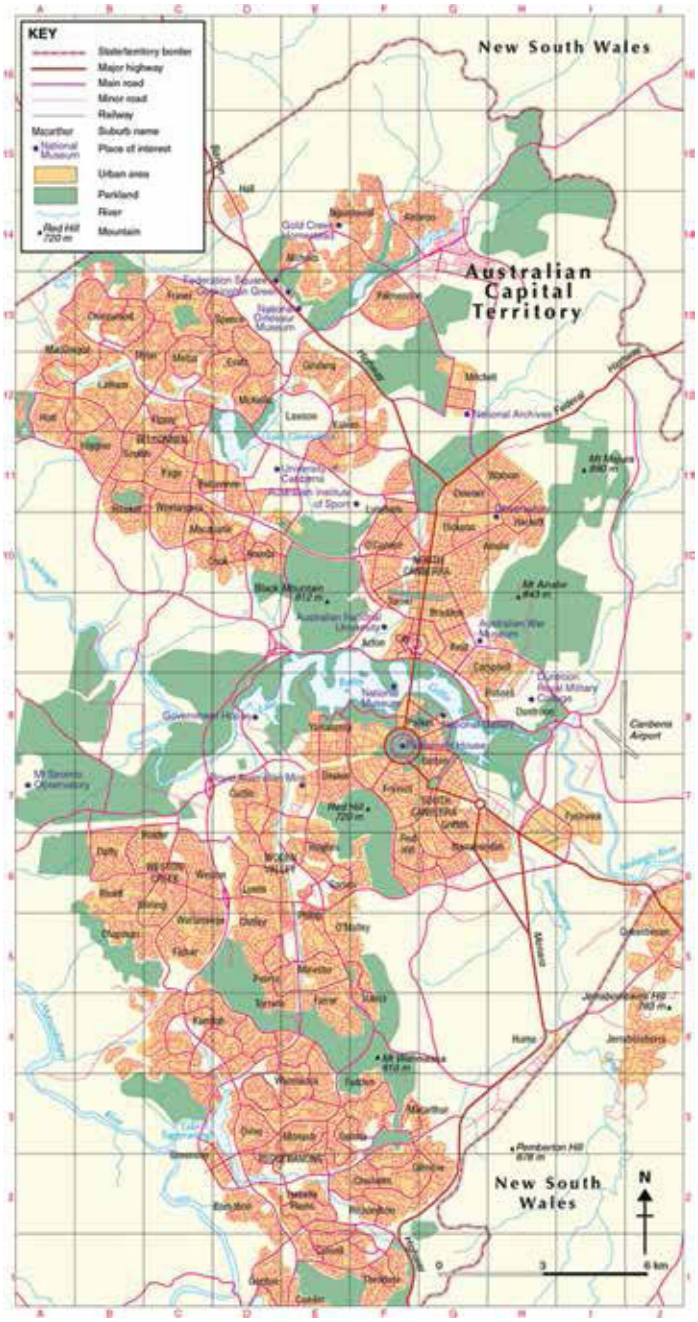
Now follow the same process using your street directory. Identify a feature. From the grid square in which your chosen feature sits, run your finger up or down the column until you see a letter in the margin. Write this down in your notebook. Go back to the grid square and run you finger across the row of squares until you see a number in the margin. Write this after the letter you wrote down. Now write the name of the feature beside the grid reference.

9.4.3 Let me do it

Developing my skills

Use a street directory and the map of Canberra shown in figure 3 to answer the questions that follow.

FIGURE 3 Canberra and its suburbs



Source: © MAPgraphics Pty Ltd, Brisbane.

Questions

1. Give grid references for the following features:
   - Canberra airport
   - Queanbeyan
   - Mt Ainslie.
2. The prime minister is hosting a group of leaders from the Asia–Pacific region. As part of their trip, the leaders will be visiting some of the local attractions in and around Canberra. Use the Canberra map and the following grid references to report on the places the group visited.
   - Before lunch the group went to E7, E13 and F11.
   - They had lunch at F9.
   - After lunch they visited G9 and H8 before making their way to A7.
   - That night they had dinner at D8.

Checklist

I have:

- run down the column of squares first and then run across the row of squares (and not the other way around)
- written the letter of the alphabet before the numeral?
- double-checked my answer.

Skills questions

1. Alphanumeric grid references on a map help us to answer the question:
   a. When did it happen?
   b. Why did it happen?
   c. Where is it?
   d. Who is it?
2. Alphanumeric grid references are written:
   a. letter first, numeral second
   b. numeral first, letter second
   c. either letter or numeral first; it doesn't matter
   d. either letter or numeral first, depending on the type of map.
3. What is an alphanumeric grid reference?
4. Why are alphanumeric grid references useful?

9.8 Environmental quality and liveability

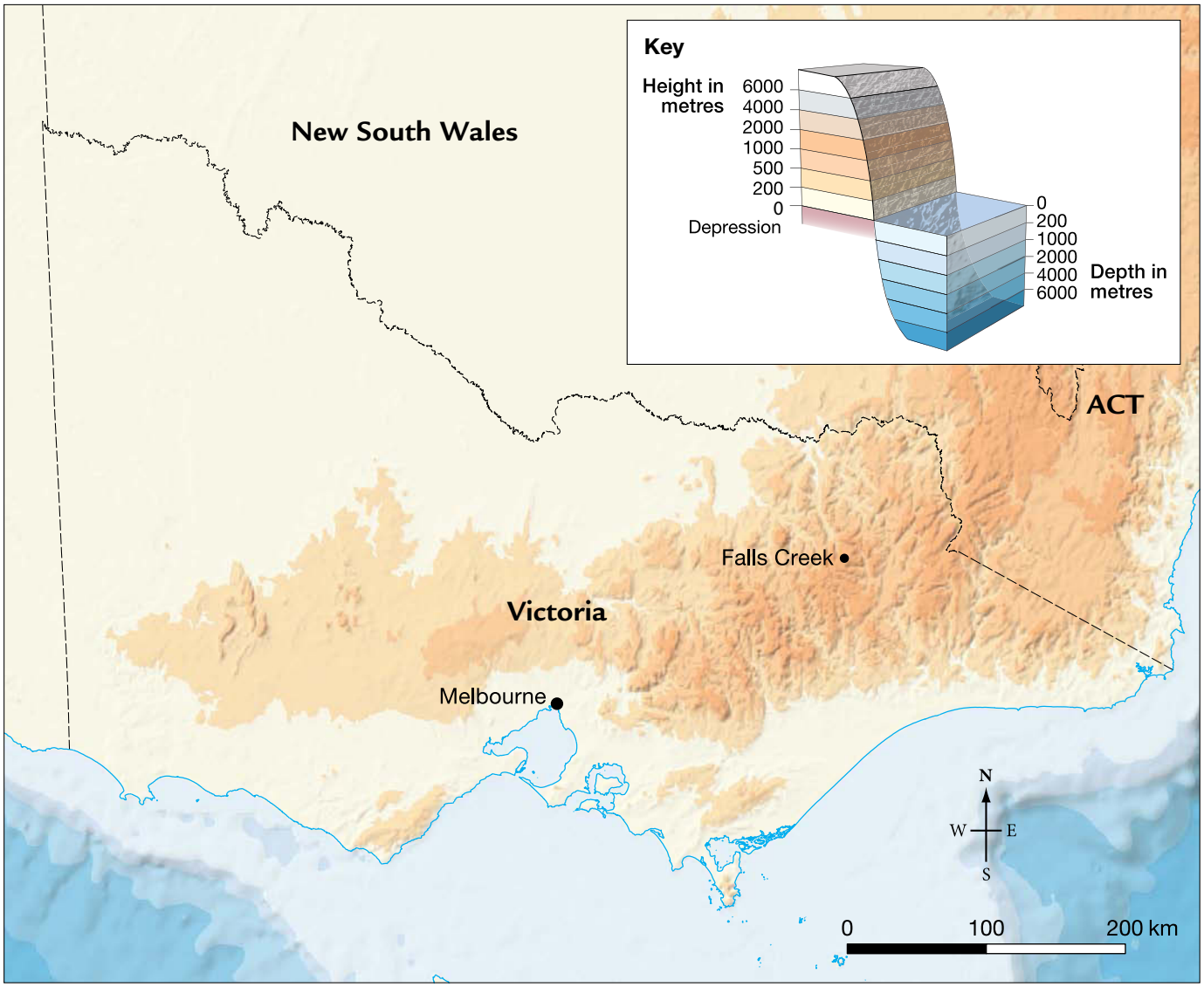
9.8.1 Falls Creek — a seasonal village

Many aspects of the way people live are influenced by the seasons. Our recreational activities, transport, housing features and clothing often change throughout the year. In some towns, there are changes in business activity and population as seasons change.

Falls Creek is located in north-east Victoria about 20 kilometres south of Victoria's highest mountain, Mt Bogong. It is in the Great Dividing Range, which extends from northern Queensland to western Victoria. As a ski resort, Falls Creek is very busy in winter and quiet in the summer. The village sits at an **elevation** of 1765 metres above sea level.

elevation height of a place above sea level

FIGURE 1 Location of Falls Creek, a ski resort in Victoria



Source: Spatial Vision

9.8.2 Climate

Falls Creek is much cooler and wetter than places at a similar latitude. It holds several rainfall and temperature records in Victoria.

- Lowest temperature: –11 °C (3 July 1970)
- Highest monthly rainfall: 989.6 mm (July 1964)
- Highest annual rainfall: 3738.5 mm (1956)

aspect the direction in which something is facing

The elevation of Falls Creek means the air is always cooler, which increases the chances of rain or snow. The southern **aspect** of the ski slopes means that the snow remains on the slopes for longer.

FIGURE 2 Elevation and temperature: the higher a place is above sea level, the less heat it receives.

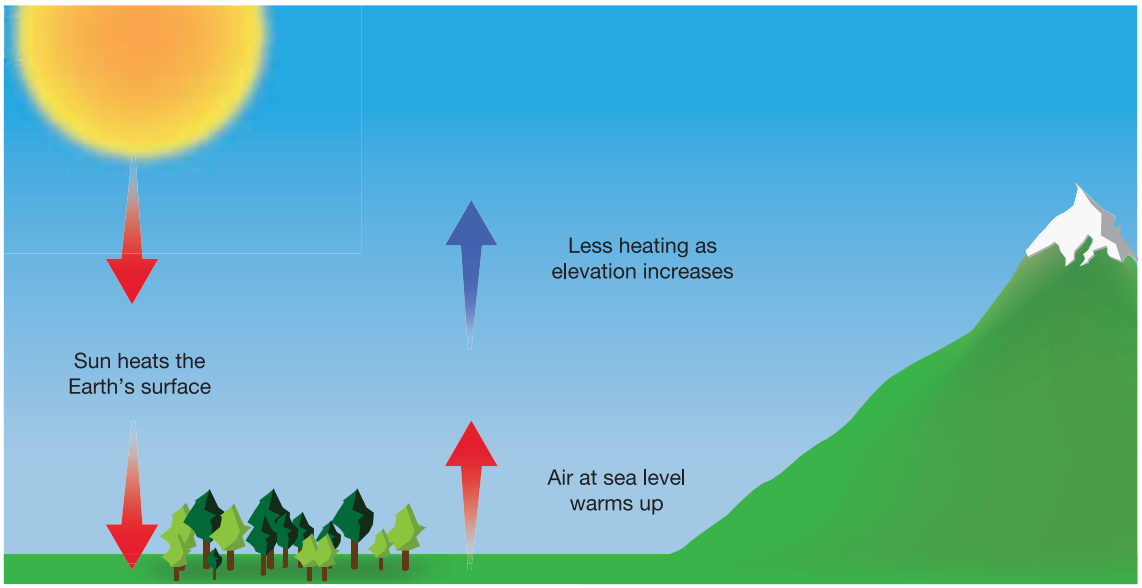
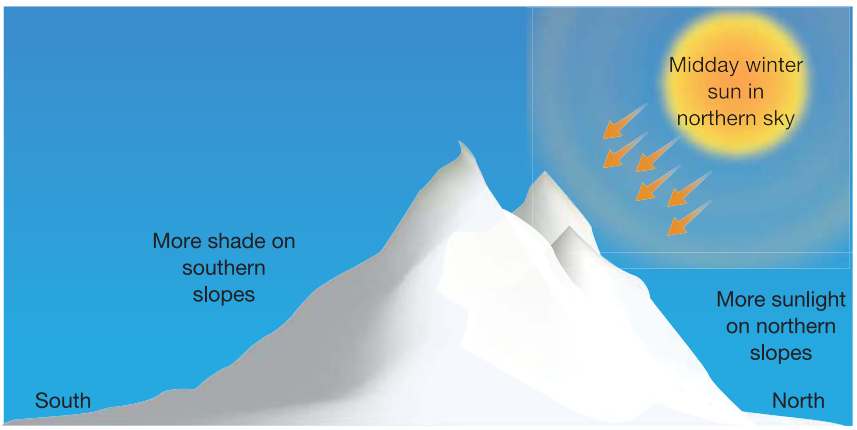
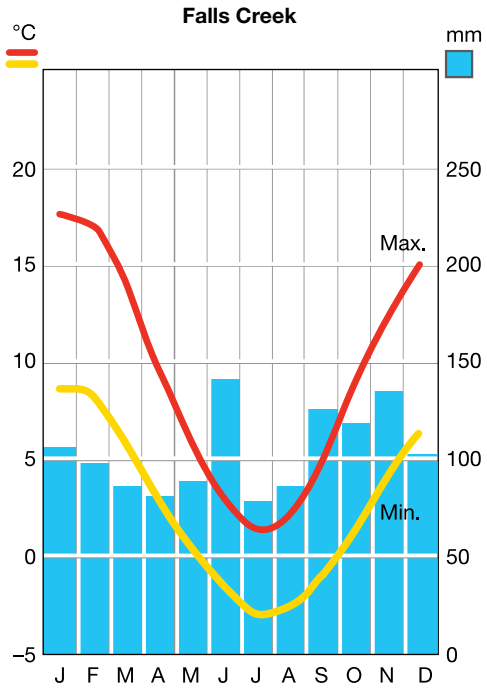


FIGURE 3 The influence of aspect on snow cover. The slope that does not face the sun is always cooler.



Snow is the major attraction at Falls Creek, and many snow-making machines are now used to improve snow cover and extend the ski season. Nearby Rocky Valley Lake provides plenty of water to feed into the high-pressure snow gun, but the temperature must also be very low (around –2 °C) for the snow machine to work.

FIGURE 4 Climate graph for Falls Creek (latitude 36.87°S)



9.8.3 Seasonal activities

FIGURE 5 Seasonal activities include skiing and bushwalking





TABLE 1 Some differences between summer and winter

Data	Summer	Winter
Population*	100 workers plus visitors	2000 workers plus visitors (can be 2500 at a time)
Visitor numbers#	35 000	130 000
Examples of type of work	Maintenance, building, road construction, revegetation and outdoor recreation	Maintenance, hospitality, snow activities, ski patrol and child minding
School enrolment*	10	40
Examples of activities	Cycling, bushwalking, fishing, altitude sports training, horse riding and tennis	Downhill skiing, cross-country skiing, snowboarding, snowshoeing, snow tubing, night skiing and snow bike riding
Special activities	Dragon boat races and alpine cycling competitions	Ice plunge, sled-dog races and skiing
Supermarkets	Open five days per week	Open seven days per week

Notes: *Numbers are approximate. # Many visitors stay for several days.

ACTIVITIES

IDENTIFY

1 In which state of Australia is Falls Creek?

2 What is the special attraction that draws people to Falls Creek?

3 According to table 1, how many more people visit Falls Creek in winter than in summer?

EXPLAIN

4 Using the description of the location of Falls Creek as a guide, describe the location of your town or city. Refer to your state, directions, distance and at least one other feature.

5 Refer to the climate graph (figure 4) for Falls Creek. In which months would you expect it to snow?

6 Explain why July would be a suitable month to operate the snow-making machines. Which other months could also be suitable?

INVESTIGATE

7 In which season is each of the following jobs most likely to be available at Falls Creek?

- child minder
- mechanic
- fitness trainer
- tennis coach
- ski instructor
- bicycle mechanic
- chef
- cleaner
- stable hand
- retail assistant

8 How do the seasons influence the way of life in your town? Identify three aspects that ***change*** according to the season.

9 In a group, brainstorm then create a list of towns that are busy in one season of the year. Choose one from the list and describe its location in at least three ways. In which season is the town busy? What is the attraction that draws people to the town?

PREDICT

10 Over the past 50 years, there has been a general trend of a slight decrease in snowfall. If this trend continues, what impact will it have on the village of Falls Creek? Consider the impact on people (social impact), on business (economic impact) and on the natural surroundings (***environmental*** impact).

APPLY

11 Falls Creek has internet and mobile phone coverage. What influence do you think this would have on access to goods and services?

12 Present the differences between summer and winter at Falls Creek in a visual format. Consider recreational activities, transport options, housing needs, clothing requirements and access to goods and services.

9.12 What is Old Delhi like?

9.12.1 Old Delhi: past and present combined

Old Delhi is an area within the modern city of New Delhi in India. Old Delhi consists of the original walled city that dates back to 1639. It was founded by the Mughal emperor Shahjahan, and was known then as Shahjahanabad. The local people pride themselves on being a peaceful community in which Muslims, Hindus and Christians have lived together side by side for hundreds of years.

The British began developing the area now known as New Delhi outside the city walls of Old Delhi in about 1911. However, life has continued within the walls of the 6.1-square-kilometre old city, which still has its original 14 gates. This makes it just a little smaller than Lake Burley Griffin in Canberra, but with a population density of over 25 000 people per square kilometre!

FIGURE 1 Even though mobile phones are found everywhere in India, there is still room for a business that offers you a telephone line when you need it. The high buildings in Old Delhi mean that mobile reception is not good in many locations within the city walls.



FIGURE 2 Building a new multi-storey building inside Old Delhi





mosques place of worship for people who follow Islam (Muslims)

FIGURE 3 People of different religions have lived in Delhi for centuries. About 80 per cent of the inhabitants of Old Delhi are Muslims, whereas in the whole of Delhi, about 80 per cent of the population are Hindu. A number of **mosques**, temples and Christian churches are crammed into the old city, including (a) the Jama Masjid (Delhi's largest mosque); (b) small but important mosques such as Kalan Masjid, built around 1387; (c) the oldest Christian church in Delhi, St James Church.







FIGURE 4 The bazaars in Old Delhi sell everything from food to bicycles.





FIGURE 5 Old Delhi is a hub of small industries, from metalwork to craft shops and food preparation. Power and telephone lines are draped from building to building.



FIGURE 6 (a) As with many other small shops in Old Delhi, the welder works with old homemade equipment. (b) The cobbler repairs shoes with a minimum of equipment, using his feet as a vice. (c) The tailor uses an old sewing machine, operated by a foot pedal.



FIGURE 7 With space almost non-existent within the city walls, buildings can only go up. There is little green or open space, so clothes lines are hung wherever they will fit.



FIGURE 8 The narrow streets make rubbish collection impossible, even if local government did offer it. The roofs of lower buildings often become rubbish dumps for those on the higher floors. In Delhi, nearly all rubbish collection is handled by private contractors or by the wastepickers.





FIGURE 9 Within the city walls, fresh milk and meat is supplied by goats, as well as by smaller animals like chickens. They share the alleys and family courtyards with the motorbikes that are a favourite form of transport.



FIGURE 10 Street food is found everywhere in the streets and alleyways.



FIGURE 11 Getting ready for *iftar*, the communal **Ramadan** festival after sunset. The place is full of a range of chaat (tangy and spicy snacks). During Ramadan, communities start to cook a fast-breaking meal in the afternoon so that it is ready for all to eat after sunset. This often takes the form of a neighbourhood banquet, celebrating friendships, family and community.







Ramadan the month of fasting in the Islamic calendar. It is a time for abstaining from food, drink and other physical needs during daylight hours, as well as reconnecting spiritually with God.

FIGURE 12 Access to clean water is a major problem in Old Delhi. There is no internal plumbing, although some households are able to obtain water through a courtyard distributor system. In general, water supply is communal in Old Delhi, just as it is in much of rural India and older urban areas. Usually, only the middle class and wealthy can afford to have running water. The courtyards of newer homes sometimes have a water tank on the roof.







FIGURE 13 Goat and other meat is killed daily and sold by butchers who cut up and sell their meat from stalls on the street.



FIGURE 14 Schools in Old Delhi exist in small buildings down side alleys. Some schools teach in the English language.



FIGURE 15 With few jobs around, young people learn to be creative in finding a way of making a living. They work in the **informal sector**. Young boys might sell cool drinks, with cordial made with water from an urn. This is then cooled by ice from a block, which is big enough to take all day to melt.



informal sector
jobs that are not officially recognised by the government as official occupations and that are not counted in government statistics. People who work in the informal sector usually generate their own employment by doing anything they can, and work long hours for very low rates of pay.

ACTIVITIES

EXPLAIN

1 Using the SHEEPT system of classification, construct a table like the one below to summarise the major features of Old Delhi and of the lives of the people who live there.

	Social features	Historical features	Economic features	Environmental features	Political features	Technological features
Feature 1						
Feature 2						

2 Wordles are word collages that summarise and highlight the important words in a particular topic. Use the **Wordle** weblink in the Resources tab to create a Wordle that uses the main words and phrases from your table in question 1.

3 Using the table that you have drawn up, identify five characteristics of Old Delhi that are very different from the ***place*** in which you live, and five characteristics that are similar.

4 Have a class debate on the statement: 'In many ways, our lives are similar to those of the people living in Old Delhi.'

5 Using Google Maps, view a map of Old Delhi. If you zoom in on this map, you will see that it names and shows the location of as many features as possible. Included in these features are the names and businesses within the walled city. Study the map and make a list of the types of businesses found in Old Delhi.

6 In what ways does the information in the list you made for question 5 help to prove that the ***environment*** of Old Delhi is part of the modern side of India?

7 Compare the living conditions of Old Delhi with those that can be seen in the ***places*** illustrated in other spreads. What similarities and differences do you notice?

INVESTIGATE

8 Use the **Delhi passport** weblink in the Resources tab to research the history of Old Delhi as a ***place***. Make a list of the key events and dates since its formation, and study a map of Old Delhi as it was in the 1800s, when it was known as Delhi.

PREDICT

9 Identify the main feature in the ***environment*** of Old Delhi that you believe to be the major problem facing its future. Justify your decision, using information from this spread and further information from internet searches and library resources.

APPLY

10 Use Google Earth to view an image of the ***space*** of Old Delhi in the present day. Using the Google Earth options, create an image of Old Delhi showing the distribution of the major human features, such as churches and mosques. Print out a copy of the map you have created.

11 Using the historical map of Old Delhi that you researched in question 8, identify some of the ***changes*** that have occurred in Old Delhi and surrounding areas since the 1880s.

12 Compare life in Old Delhi with life in India today.

eBook*plus*

Weblinks
- Delhi passport
- Wordle

9.13 How is modern India changing?

9.13.1 The multiple realities of India

Modern India is a very complex place. Indians themselves often talk about the 'multiple realities' of India. This means that there are many different pictures that visitors might see of life in India. Some of these may contradict each other, yet all of them are true.

There is a great difference between modern India and traditional India. The country is in the top 10 national economies of the world. Since the 1990s, government policies have encouraged industrialisation, which has given jobs to many people and money for them to spend. India has almost 1.3 billion people, and there is now an increasing number of middle-class citizens who are highly educated, earning high incomes, and wanting the type of lifestyle that money can bring. In 2015, India had more than 90 billionaires (in US dollars), and almost 5 per cent of the world's billionaires.

However, the gap between rich and poor is increasing. Economic growth has decreased the number of people living in poverty, but over 40 per cent of the population still lives in very basic conditions. Around 70 per cent of people still work in agriculture, and the rural poor are substantially worse off than other Indians. Incomes for farm workers are well below average.



FIGURE 1 In rural areas, many of the poor work in the informal sector. This snake charmer is one of a dying profession, working mainly for tourists and in festivals and markets, despite the fact that it is now illegal. The serpent is sacred in Hinduism, and snake charmers were once thought to have gifts of healing.



FIGURE 2 The modernisation of India has seen the rise of the service station roadside stop on major highways, like this one between Delhi and Agra.



FIGURE 3 A long drought in the 2000s put great pressure on dwindling water supplies in India, particularly in the countryside. However, urban growth and few environmental controls on local industry have also led to the pollution of small yet important lakes, like this one near Agra.











FIGURE 4 The contrast of modern India: (a) When modern buildings are constructed, bamboo poles are still used as scaffolding. (b)—(d) The growing middle class has created a 'westernised' lifestyle for many Indians, where people place great importance on always buying new goods and services. This can be seen in the advertisements within large shopping centres. (e) There is still room for local customs, however: look at what is on the sign hanging above the front of the McDonald's store. Is this type of customer service what you would find at your local McDonald's store?

FIGURE 5 A large proportion of India's economic growth has been in the **service sector**, where people work in jobs providing skills ranging from gardening and laundry to accountancy. For instance, many businesses in North America, Europe and Australia have 'outsourced' their telecommunications and work to **call centres** in India. This means that they hire people in India to do jobs that are more expensive to have done locally. Many global companies, like the one in this photo, now have bases in India.



service sector the sector of the economy in which people provide assistance or skills (rather than goods) to a customer or client. Examples of jobs within this sector are doctor, accountant, salesperson, teacher, police officer and IT repair specialist.

call centres a telecommunications base where operators take calls from customers on behalf of many companies, dealing with anything from sales and complaints to technical assistance

FIGURE 6 The educated Indian middle class is growing so quickly that Indian radio stations can afford to target very specific audiences.



FIGURE 7 Advertising posters such as this can tell us many things about Indian society.



FIGURE 8 Three methods of transport in modern India







ACTIVITIES

INVESTIGATE

1 Using the SkillBuilder 'Annotating a photograph' in subtopic 13.5, construct a list of points about modern India that you can obtain from each place described in the photos and captions in this spread.
2 For each point, indicate whether the observation makes a statement about:
   a India of the past
   b India in the present
   c India in the future.

EXPLAIN

3 Study figure 7. As the economy of India has grown and the country as a whole has become wealthier, Indian society has changed in ways that are not always obvious. Look at the messages that are given by the images and text on the advertising posters in figure 7. What do they say about how a wealthy, modern person should look? Conduct a class discussion about whether these kinds of attitudes are desirable or not.

APPLY

4 One of the areas where the growth of the wealthy class in India can be seen is in sport. Use the **Indian Premier League** weblink in the Resources tab to research the structure of the Indian Premier League (IPL) in cricket. Create a map showing where the different teams are based in India. Construct a table of the names of the owners and how they created their fortunes. What conclusions can you draw about the IPL as a symbol of modern India?

eBook*plus*

Weblink
Indian Premier League

9.14 Review

9.14.1 Review

1. Explain the importance of the following factors in why people choose to live where they do.
   - transport
   - water
   - shopping centres
2. Describe the services and facilities available in country towns that promote social connectedness among their residents.
3. Describe the services and facilities that make country towns liveable.
4. Explain how the quality of the ***environment*** increases liveability.
5. Describe the factors that influence community identity.
6. How and why do people live in Dawson, Canada, today?
7. Explain what makes your community so liveable.

9.14.2 Reflect

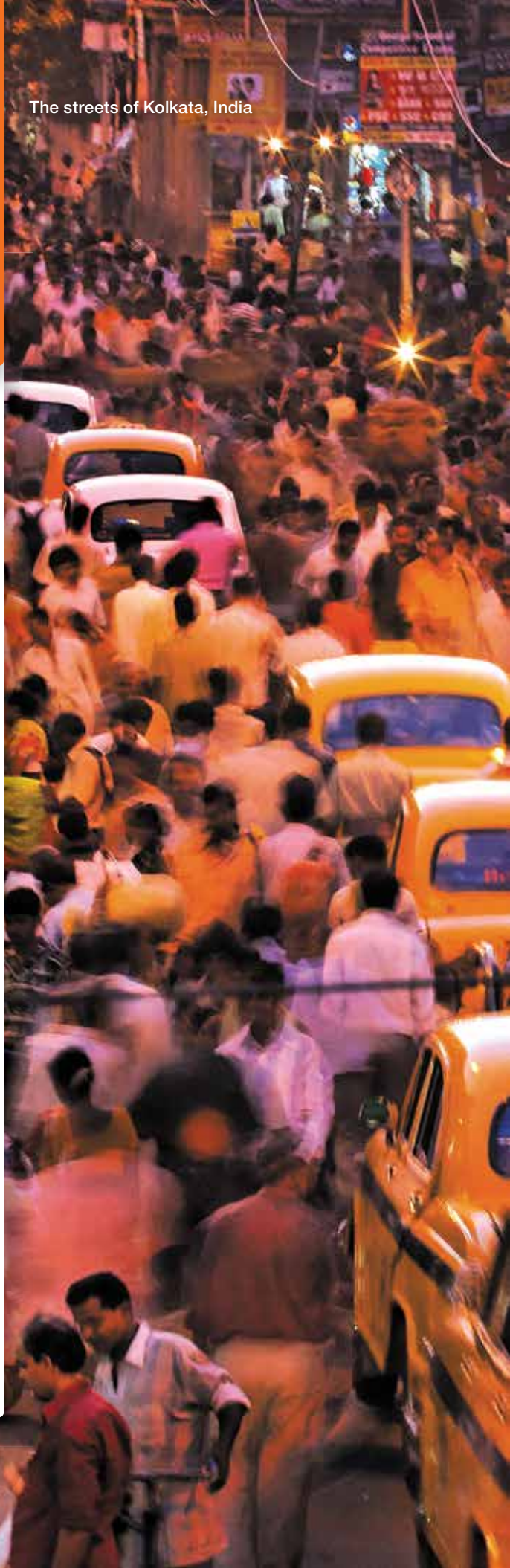
8. Examine the following table and then answer the questions.

TABLE 1 Selected crimes in NSW region, 2014, per 100 000 population

Crime category	New South Wales	Sydney	Forbes	Bega
Burglary (residential)	301	642	693	189
Assault	881	2261	1769	732
Robbery	46	199	0	0
Theft from motor vehicle	576	209	962	48
Theft (retail)	276	1205	114	123

Source: http://www.bocsar.nsw.gov.au/Pages/bocsar_crime_stats/bocsar_lgaexceltables.aspx

a. Construct a series of column graphs to represent the crime statistics in New South Wales, Sydney, Forbes and Bega.
b. Compare the crime rates in New South Wales with those in Sydney, Forbes and Bega, as revealed in your graphs.
c. How does crime impact liveability?
d. What might the residents of Sydney, Forbes and Bega think about the liveability of their areas?



The streets of Kolkata, India

CHAPTER 10

Liveable places

10.1 Overview

10.1.1 Introduction

Your quality of life is influenced by many factors, such as climate, landscape, community facilities, the location of your home, the sense of community identity, and links to other settlements. You probably have an idea of a street, town, city or suburb where you would like to live, and your opinion may be quite different from those of others. This is because other people see different factors as important. This chapter will look at how people define and improve liveability.

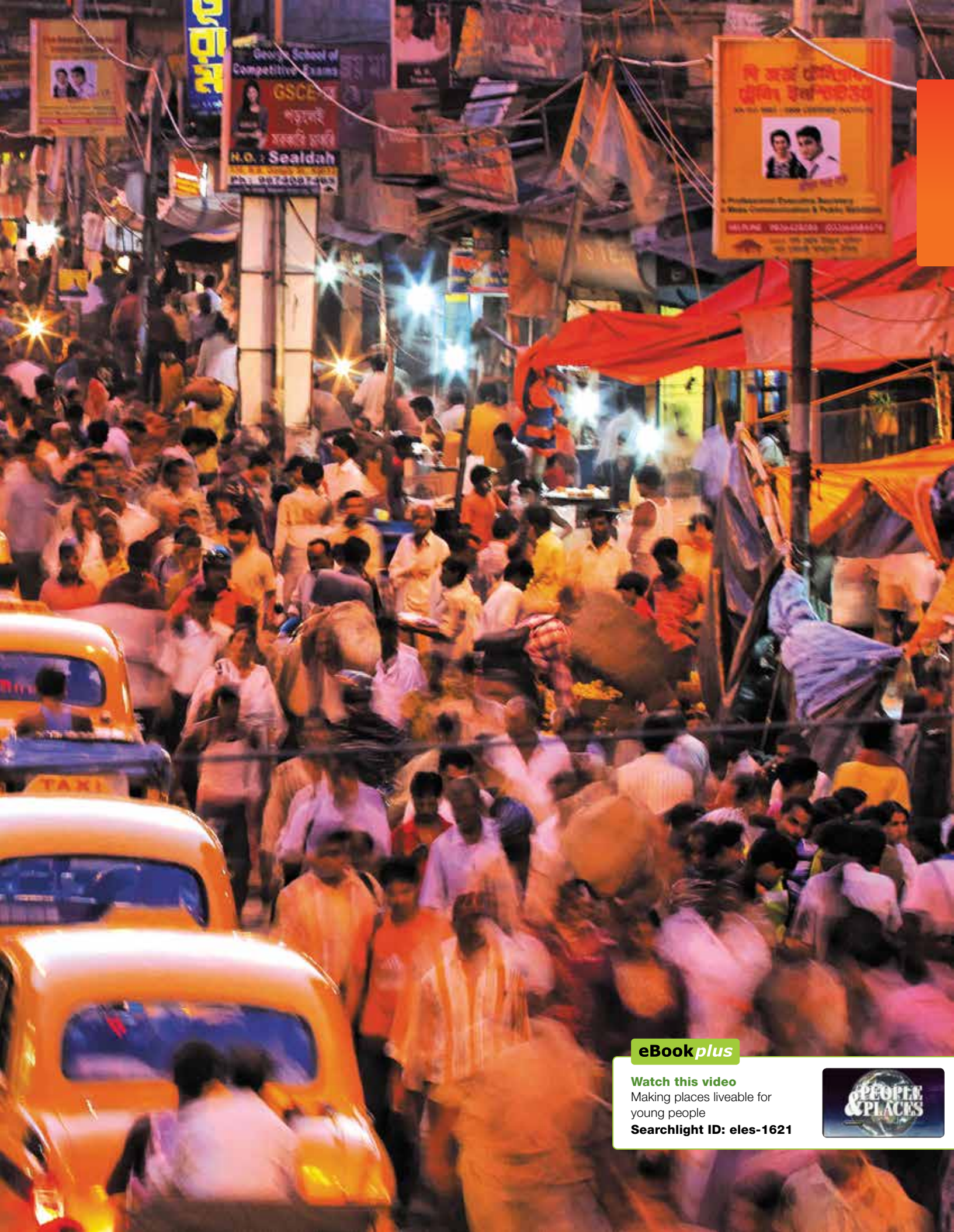
Starter questions

1 What would be the good things about living in the city shown here?
2 What would be the more challenging aspects about living in this city?
3 a What similarities and differences are there between this ***place*** and where you live?
b In which of these two ***places*** would you prefer to live and why?

Inquiry sequence

		Syllabus outcomes
10.1 Overview		
10.2 What is liveability?		GE4-6
10.3 What makes a place liveable?		GE4-3, GE4-4
10.4 SkillBuilder: Drawing a climate graph	eBook*plus* ONLINE ONLY	GE4-1, GE4-7
10.5 Where are the most liveable cities?		GE4-1, GE4-8
10.6 What makes Melbourne the world's most liveable city?	eBook*plus* ONLINE ONLY	GE4-7, GE4-8
10.7 How can liveability be improved?		GE4-3, GE4-4, GE4-6, GE4-8
10.8 Investigating topographic maps: What is liveability like in Badu and Moa?		GE4-6
10.9 Port Moresby — a less liveable city?		GE4-6
10.10 Dhaka — a less liveable city?	eBook*plus* ONLINE ONLY	GE4-4, GE4-6
10.11 What makes a place liveable for you?		GE4-1, GE4-8
10.12 SkillBuilder: Creating and analysing overlay maps	eBook*plus* ONLINE ONLY	GE4-1, GE4-7
10.13 How could my community be made more liveable?		GE4-6, GE4-7, GE4-8
10.14 Review	eBook*plus* ONLINE ONLY	
Key terms	eBook*plus* ONLINE ONLY	





eBook*plus*

Watch this video
Making places liveable for young people
Searchlight ID: eles-1621

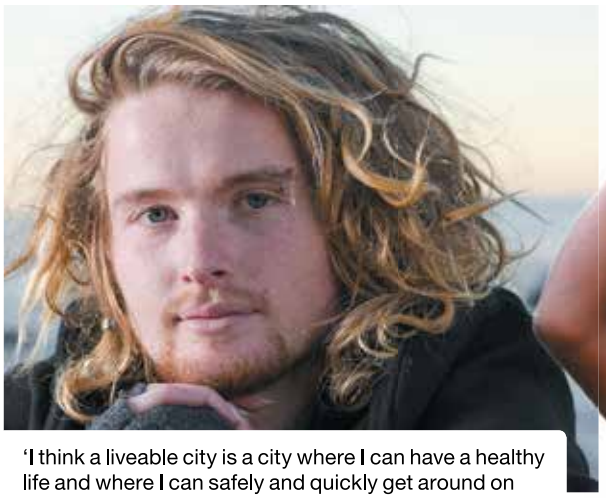
10.2 What is liveability?

10.2.1 What do people think about liveability?

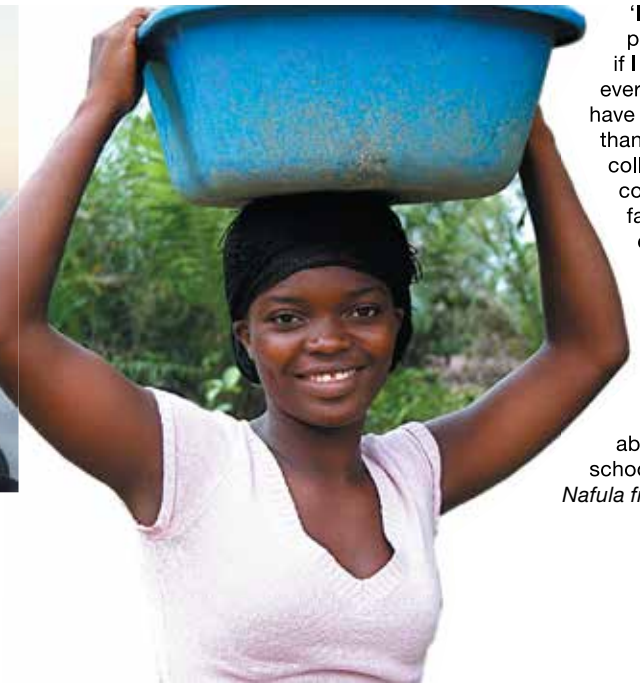
Liveability can be defined as 'the features that create a place that people want to live in and are happy to live in'. It is usually measured by factors such as safely, health, comfort, community facilities and freedom.

community a group of people living in a particular region

Here are some examples of what people think about the liveability of their **community**. They come from different places and they are all trying to explain what liveability means to them.



'I think a liveable city is a city where I can have a healthy life and where I can safely and quickly get around on foot or by bicycle, public transport or even by car — as a last resort. A liveable city is a city for everyone, including children and old people, rich and poor, and people of different religions, races and fitness levels. A liveable city should be attractive, and have good schools, a choice of things to do and fresh air.'
John from Perth



'I think that a place is liveable if I have food every day, I do not have to walk more than 10 minutes to collect water for cooking and my father has work close by, so he is home for dinner. Liveability means warm weather, enough rain and being able to go to school every day.'
Nafula from Kenya



'Liveability means that I have a good job, good food, a nice house, a newish car, nice neighbours and a community that cares about my family and me.'
Oscar from western suburbs of Sydney

'A liveable place is somewhere I can have a computer and a television and a bed of my own in my own room. I would like a bike to get to school, three meals a day and two sisters. A liveable place would be clean, safe and modern. My grandmother and aunty would also live with us.'
Jing from a village in rural China



‘Liveability is all about the **natural environment**. I think a place is liveable if the air is clean, there is plenty of water in the river and there is a healthy forest nearby. Being able to grow your own food, use renewable energy and live a simple life are all a part of what is important to me and can make a place liveable.’
Joy from Huon Valley, Tasmania





‘The community is what makes a place liveable. Being connected with my neighbours, through the community gardens, food co-op, volunteer network at our kids’ school and the car-share scheme all make me feel a valued member of my community. I like knowing people who care and that we all care for each other.’
Laura from Bristol, United Kingdom

natural environment elements such as wind, soil, flowing water, plants and animals that influence the characteristics of an area



‘Liveable cities have housing that is close to jobs, services and transport and is available for all income levels. Neighbourhoods are pedestrian-friendly with green spaces and lively retail sectors. They are mostly car-free, and have good schools and public buildings. A liveable city needs lots of different choices — choices in ways to live, places to work, shop and eat, and locations to linger in — whether alone or with other people.’
Alex, property developer from New York



‘A liveable community offers many activities, celebrations and festivals that bring all of its residents together. Every year at Carnevale, my whole neighbourhood comes together to dance the samba. I would never wish to live anywhere else.’
Raul from Rio de Janeiro



‘The place that I think would be the most liveable is Darwin. It has great footy grounds, public transport, good food, good houses, good shops and good schools. Where I live, my house is a dump and I cannot get anywhere unless I walk. I would like to live in Darwin and play football.’
Sam from near Alice Springs

distribution the way things are spread across an area

ACTIVITIES

EXPLAIN

1 Write a statement, similar to those in this section, about the community that you live in and what makes it liveable.

2 Would the statement of liveability in your community be different if you were blind, unemployed, elderly or unable to speak English? Write what you think a community liveability statement would be for two such residents of your community.

INVESTIGATE

3 Carefully read the different opinions about what makes a place liveable.
- **a** Make a list of the common themes mentioned by these people.
- **b** Is there a shared common definition of what makes a place liveable? Discuss the differences with your class.
- **c** On a map of the world, show the location of each ***place*** mentioned in this section.
- **d** Does the ***place*** in which each person lives appear to influence their definition of the term *liveability*? Discuss this with your class.

4 **a** Ask a much older person to describe the living conditions in the community they lived in as a teenager. Record or write down their memories.
- **b** Do you think the current liveability of your community is better than that described by the older person? Provide an example to support your view.

PREDICT

5 **a** Think about your community 50 years from now. What ***changes*** do you think will happen during this time? Consider the **distribution** of houses, the type of houses, the amount of traffic, the age of the population, the community facilities and other aspects you think will be significant.
- **b** What type of inventions might improve liveability?

APPLY

6 We have described liveability here in a general sense. Provide examples of how living conditions ***change*** from time to time. Are the ***changes*** in your examples due to natural events or human activities?

7 **a** Which viewpoint or viewpoints about liveability do you agree with more than others? Give reasons for your answer.
- **b** As a class, discuss your answer to question 7(a), and see if there are any patterns within the group.

10.3 What makes a place liveable?

10.3.1 Who says which is the most liveable?

Liveability is measured by several different international surveys. The Quality of Life Index, Happy Planet Index, Most Liveable Cities Index, Mercer Quality of Living Survey and the Global Liveability Ranking are examples of some of these. Your *Jacaranda Atlas Eighth Edition* (p. 168) has illustrated some of their recent results.

Several international organisations have created lists of the world's most liveable cities. These organisations each compare data and produce a table that ranks the liveability of cities. This information is collected for workers considering overseas transfers or for companies that may need to compensate workers who are transferred to a low-ranked city. The figures can also be used to attract migrants or investment. The various rankings compare a large number of cities; however, not all cities in the world are included in each survey.

Liveability surveys were created by international organisations who collect and compare data on different cities around the world. The data is then placed in a table that ranks how liveable a city is.

Cities that are considered to be the most liveable meet lots of different criteria to ensure safety, education, income and culture of the community. The criteria used to produce rankings vary from survey to survey. They generally include some the following:

- stability or personal safety (crime, terror threats and civil unrest)
- healthcare
- culture and environment (religious tolerance, corruption, climate and potential natural disasters)
- education
- infrastructure (transport, housing, energy, water and communication)
- economic stability
- recreational and sporting facilities
- availability of consumer goods (food, cars and household items).

10.3.2 Characteristics of less liveable cities

According to the Economist Intelligence Unit, civil unrest, acts of terror and violence have resulted a decline in liveability in some cities around the world. Conflict of any kind is damaging to a city's ranking. It decreases the quality of infrastructure, burdens hospitals and reduces the availability of goods, services and activities available to the community.

TABLE 1 The five least liveable cities

Country	City	Rank (out of 140)	Overall Rating (100 = ideal)
Libya	Tripoli	136	40
Nigeria	Lagos	137	39.7
PNG	Port Moresby	138	38.9
Bangladesh	Dhaka	139	38.7
Syria	Damascus	140	29.3

10.3.3 Liveability and sustainability

Australia's major cities often rate amongst the most liveable. Liveability, however, is not always the same as sustainability. Sustainability considers how well a community is currently meeting the needs and expectations of its population and how well it will be able to continue providing for its population.

Indicators that a place is sustainable include:

- low working hours to meet basic needs
- high renewable energy use, low non-renewable energy use
- plenty of recycling and composting
- low vehicle kilometres travelled
- good water, forest, marine health
- high air quality
- biodiversity
- healthy living
- easy access to education.

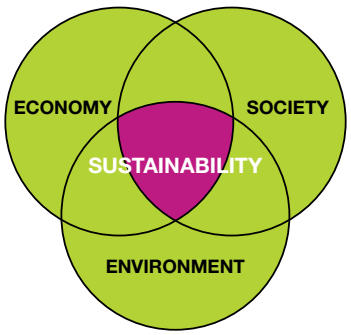


FIGURE 1 To achieve sustainability, a city's environmental, economic and social aspects must all be considered.

ACF sustainable city index

The Australian Conservation Foundation's sustainable cities index tracks progress on sustainability in Australia's 20 largest cities. It calculates a score based on 15 different indicators: air quality, ecological footprint, **green buildings**, water, **biodiversity**, health, density of settlement, wellbeing, transport, employment, climate-change readiness, education, food production, public participation and household debt.

In 2010, there were only small differences between the 20 largest cities. Some key findings were:

- the Sunshine Coast had the best air quality
- Brisbane scored highly in the health category
- Townsville displayed biodiversity
- Canberra and Melbourne had many green buildings
- Sydney rated highest in population density
- Perth had a very high rate of car ownership.

TABLE 2 Australian cities sustainability index, 2010

	Position	Score
Darwin	1	119
Sunshine Coast	2	121
Brisbane	3	123
Townsville	4	129
Canberra (Queanbeyan)	5	133
Hobart	6	139
Melbourne	7	142
Gold Coast (Tweed)	8	143
Cairns	9	145
Bendigo	10	150
Toowoomba	11	152
Sydney	12	161
Launceston	13	163
Adelaide	=14	165
Ballarat	=14	165
Albury–Wodonga	15	167
Wollongong	16	171
Newcastle	17	172
Geelong	18	174
Perth	19	183

Source: www.acfonline.org.au/sites/default/files/resources/2010_ACF_SCI_Report_Comparative-Table_and_Fact-Sheets.pdf

green building building that requires fewer resources when being built, and uses power and water efficiently

biodiversity the rich variety of all life forms on Earth, including plants and animals

ACTIVITIES

IDENTIFY

1 List three criteria included in a liveability survey.
2 What factors make a city less liveable? Why do these factors make a city less liveable?
3 Which cities in the world are least liveable?
4 Which cities have experienced:
  a increases in liveability?
  b decreases in liveability?
  c Suggest what might have led to these changes.

EXPLAIN

5 Describe the distribution of the least liveable cities around the world.
6 How many of the least liveable cities are found on each continent?
7 How many of the least liveable cities are found in each hemisphere?
8 How can ***sustainability*** be linked to liveability? Give examples and reasons to support your answer.

APPLY

9 Refer to table 2 and a map of Australia in your atlas. Use these to decide whether each of the following statements is true or false. Provide reasons to support each choice.
  a More than half of the top 10 sustainable cities are located on the coast.
  b The cities out of the top 10 are all located south of latitude 30°S.
  c New South Wales has the greatest number of sustainable cities in the top 20.

PREDICT

10 What do you think could be done to improve a city's liveability ranking?

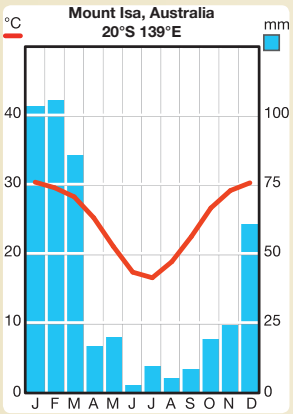
myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
Christie Walk
Mawson Lakes

eBook*plus* ONLINE ONLY

10.4 SkillBuilder: Drawing a climate graph

What are climate graphs?

Climate graphs, or climographs, are graphs that show climate data for a particular place over a 12-month period. They combine a column graph and a line graph. The line graph shows average monthly temperature, and the column graph shows average monthly precipitation (rainfall).



eLesson
Watch this video to learn how to draw a climate graph.



Searchlight ID: eles-1644

Interactivity
Try this interactivity to learn how to draw a climate graph.



Searchlight ID: int-3140

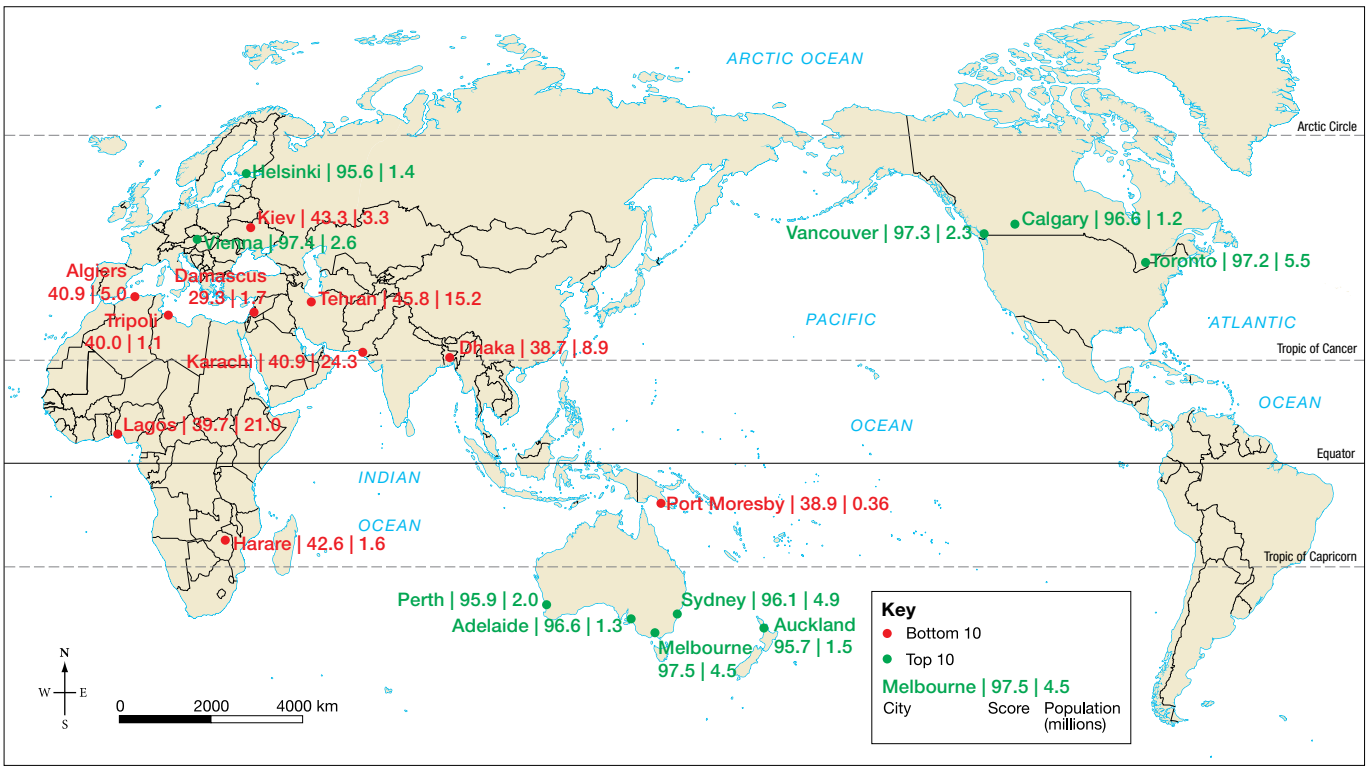
10.5 Where are the most liveable cities?

10.5.1 City liveability

Everyone likes to be able to tell you they are the best, or in the top 10 of some category. Cities are no different. If you look at the official websites for many international cities, they will tell you that they are the safest, wealthiest, fastest-growing or have the best events calendar. Being able to boast that a city is the world's most liveable is great publicity.

Figure 1 shows the top 10 and bottom five in the global cities liveability rankings, as released by the Economist Intelligence Unit (EIU) in August 2015. These rankings are updated each year, so it is possible for you to log on to get the most recent rankings. This survey ranks 140 cities; a score of 100 equates to the perfect or ideal city. For the past few years, Melbourne, Vancouver and Vienna have dominated the top rankings.

FIGURE 1 City liveability ranking, top 10 and bottom 5



Source: Economist Intelligence Unit (EIU), August 2015.

10.5.2 What do these top 10 liveable cities have in common?

Looking at the locations of the most liveable cities, you can see most are found in Australia, Canada or Europe. They are all mid-sized cities and rarely have more than four million inhabitants. These cities have quite low **population density**, low crime rates, and infrastructure that copes quite well with the needs of the local community. They are found in places where the climate is **temperate**, perhaps with the exception of Toronto, Calgary and Helsinki, which do have very cold winters. The top cities also tend to be modern cities, not much more than 300 years old. They have been planned so that people can travel around them by both public and private transport. They are also found in some of the world's wealthiest or most developed nations.

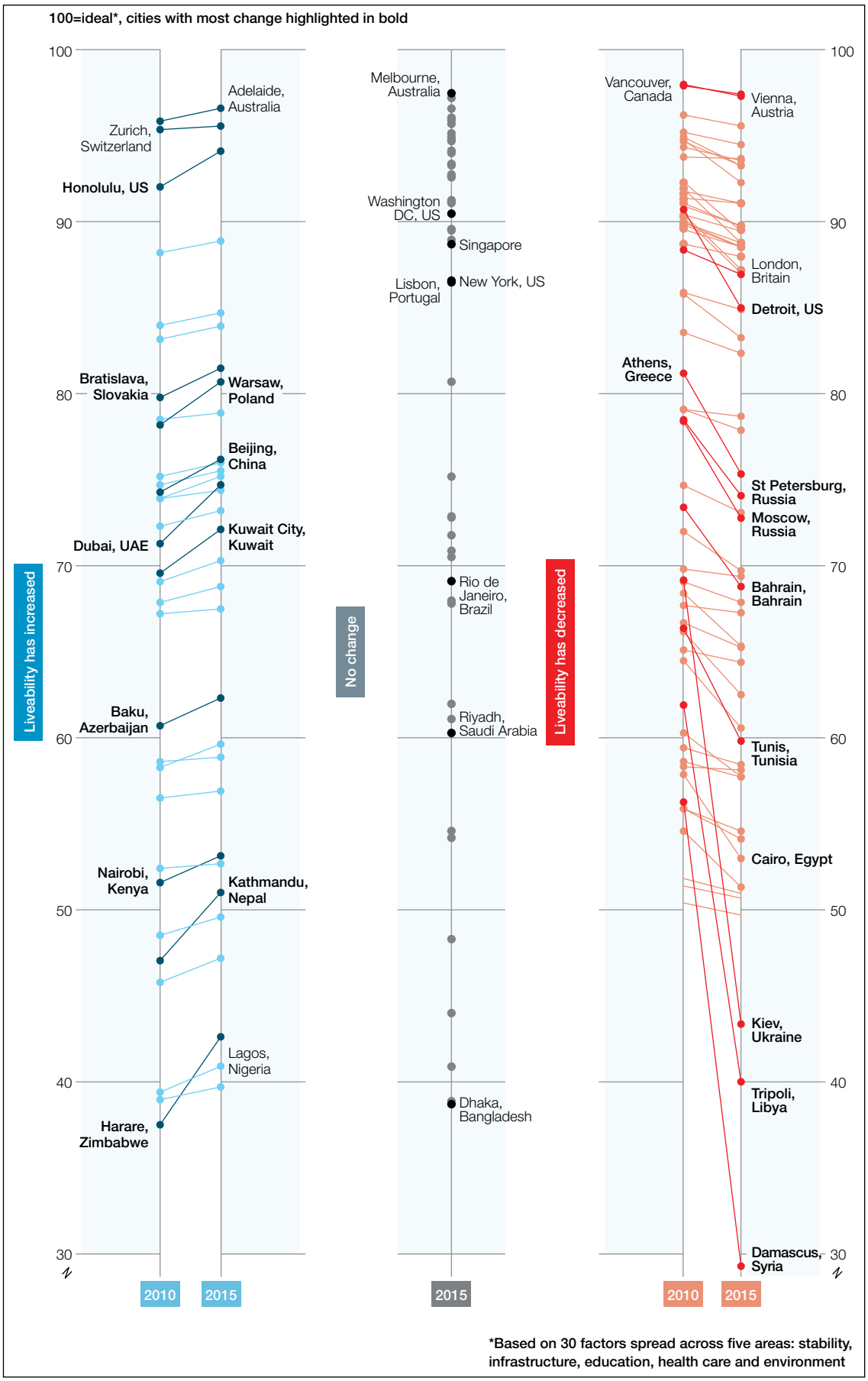
Australian and Canadian cities perform better than cities in the United States due to the higher crime and congestion rates in US cities.

Figure 2 shows the recent change in liveability. Some cities have increased, some have decreased whilst other have experienced no change at all.

population density the number of people living in a square kilometre

temperate describes the relatively mild climate experienced in the zones between the tropics and the polar circles

FIGURE 2 City 'sustainability index'



Source: Economist Intelligence Unit

GEOskills TOOLBOX

Line graphs

Line graphs measure change over a period of time. Multiple line graphs can be drawn to compare multiple groups over the same period of time. Line graphs are simple to construct, whereby you draw a series of points that are then joined together by straight lines.

Figure 2 compares the change in the liveability of cities between 2010 and 2015. The scale on the *y* axis determines how much a city has increased, decreased or stayed the same. For example, Honululu (USA) has increased by approximately 4 points. In contrast, Damascus (Syria) has decreased by approximately 27 points on the liveability index.

ACTIVITIES

IDENTIFY

1 Define population density.
2 What do the top 10 most liveable cities have in common?
3 Which cities experienced no change in ***sustainability*** between 2010 and 2015?

EXPLAIN

4 Why do Australian and Canadian cities outperform the United States in liveability?
5 **a** List three cities that improved their ***sustainability*** index between 2010 and 2015.
b How might these cities have improved their ***sustainability*** between 2010 and 2015?
6 **a** List three cities that experienced a decline in ***sustainability*** between 2010 and 2015.
b Suggest reasons why these cities' ***sustainability*** declined between 2010 and 2015.

APPLY

7 Why might people be interested in the liveability and ***sustainability*** survey results?
8 What is the advantage of comparing data collected from 2010 and 2015?

INVESTIGATE

9 Select one of the top 10 liveable cities and one of the bottom five liveable cities. Use the internet to find a news article for each city about why your chosen city is/is not liveable. Stick the news article in your exercise book and write a paragraph explaining how it reflects an increase or decrease in liveability in your chosen cities.

eBookplus

Interactivity
My most liveable city
Use this interactivity to work out which city you would like to live in based on your own criteria.
Searchlight ID: int-3095

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › **Polluted cities**

eBookplus ONLINE ONLY

10.6 What makes Melbourne the world's most liveable city?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

10.7 How can liveability be improved?

10.7.1 Sustainable development goals

Many countries cannot afford to provide infrastructure for their growing population. The underlying cause of very low liveability is poverty. Reducing poverty is fundamental to improving living conditions in many parts of the world.

In 2015, the United Nations replaced the Millennium Development Goals with the Sustainable Development Goals. There are 17 goals that have an economic, social and environmental focus (see figure1). Within the goals, there are 169 targets which aim to improve liveability across the world by 2030.

Australia's aid program

global citizen someone who is aware of the wider world, tries to understand the values of others, and tries to make the world a better place

The Australian government recognises that we are **global citizens**, and it supports an overseas aid program through its agency Australian Aid (see figure 2). Overseas aid helps improve outcomes in health, education, economic growth and disaster response in many locations.

FIGURE 1 Sustainable Development Goals



Australian Aid runs projects to improve living conditions, often working with other countries or with **non-government organisations (NGOs)**. NGOs also run programs of their own. Well-known NGOs include World Vision, CARE Australia and the Red Cross. Aid from Australia is given to many countries around the world. The Australian government gives particular preference to the Indo–Pacific region.

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

Small changes, big results

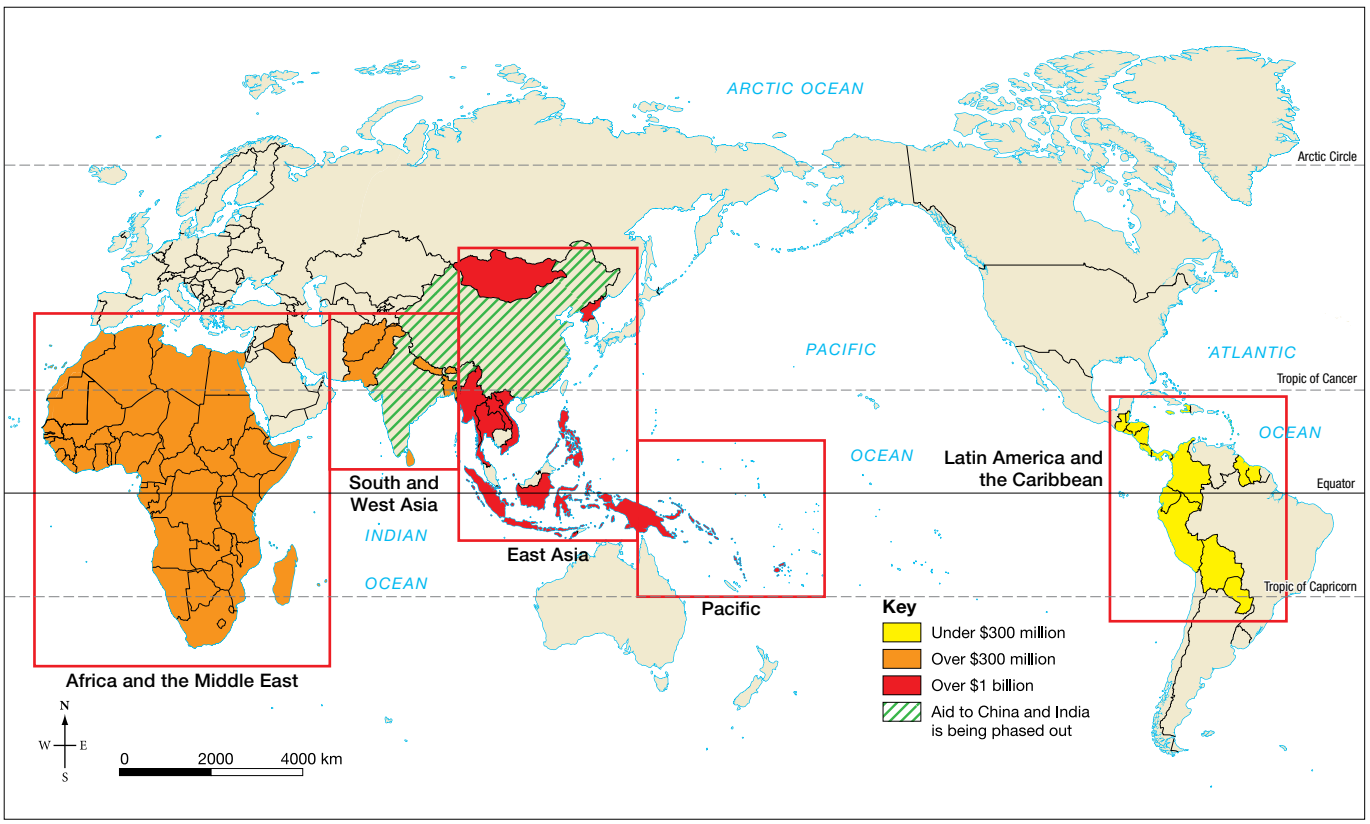
Simple technology can make an enormous difference to people's lives in developing countries (see figure 3).

FIGURE 2 Australian Aid logo

Australian Aid

In addition, a small amount of money can sometimes create a big difference to an individual or community group. Microfinance, or microcredit, is a system of lending small amounts of money, perhaps $150. The borrowers are usually women, and the money is used to invest in something that can generate income. A person might buy an animal for milking and breeding, equipment for basket-making, stock for a store, or materials for jewellery-making. The loan must be repaid, but at a low interest rate, and further loans can be taken out.

FIGURE 3 Regional distribution of Australian aid, 2015–16



Source: Spatial Vision

FIGURE 4 Examples of projects to address Sustainable Development Goals. (a) A child immunisation clinic on the Kokoda Track (b) Building schools and improving education in Indonesia (c) Planting grasses in Fiji to stabilise sea banks

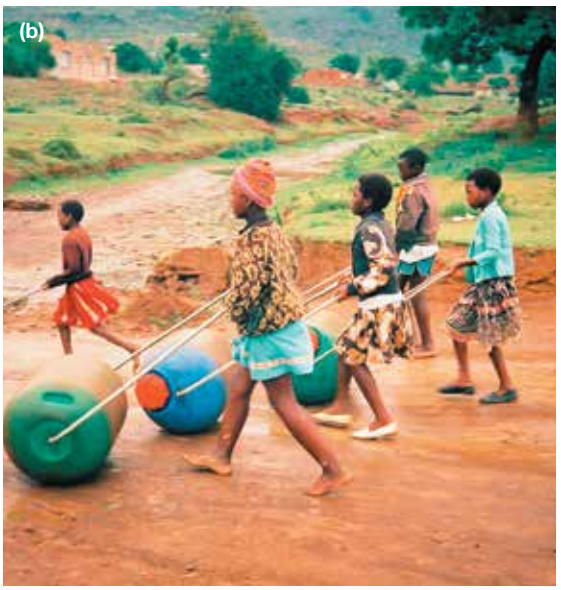






FIGURE 5 Appropriate technology. (a) Electricity in Nepal is not available to all houses, so a solar lamp increases the opportunities to read. (b) In South Africa, people push hippo rollers, which make it easier to collect water from distant wells and bring it home.





appropriate technology technology designed specifically for the place and the people who will use it. It is affordable and can be repaired locally.

eBook*plus*

Weblink
Sustainable development

ACTIVITIES

IDENTIFY

1 a Which organisation developed the Sustainable Development Goals?
b How many goals are there?
c What is the aim of the Sustainable Development Goals?
2 By which date are the goals to be achieved?

EXPLAIN

3 Study the images in figure 4. Which Sustainable Development Goals have been addressed in these projects?

INVESTIGATE

4 Refer to figure 3. Identify the region in which each of these aid-receiving countries is located: Afghanistan, East Timor, Ethiopia, Nicaragua, Vanuatu.
5 Prepare a report about the work of one NGO involved in programs that aim to improve liveability in an overseas country. Include background information about the location of the project (country and locality); statistical data about living conditions (such as life expectancy, access to safe water, doctors per 100 000 people); and ***environmental*** conditions. Describe the NGO and its project and how it is aiming to improve liveability.

APPLY

6 Choose one of the sustainable development goals. Use a visual organiser to explain how achieving this goal will improve liveability. Take into account the flow-on effects and the impact on people, the economy and the ***environment***.
7 Use the **Sustainable development** weblink in your eBookPLUS to research the targets within each of the Sustainable Development Goals. Write a paragraph explaining how the goals are related. In your opinion, are they achievable?
8 Select one NGO that the Australian government works with and create a report describing what they do to help improve liveability.

10.8 What is liveability like in Badu and Moa?

10.8.1 Badu and Moa islands

Both of these islands are located 40–60 kilometres off the far north Queensland coast in the Torres Strait. Moa Island has a small population of approximately 240 people. Badu Island has a slightly larger population of around 850 people.

These small isolated communities rely on the ocean to provide food and as a pathway for trade. Their livelihood is threatened by climate change, particularly rising sea levels. Communities on the islands are heavily reliant on regular rainfall and have reservoirs to ensure a secure clean water supply. More recently, septic tanks and drainage facilities have been installed improving the environmental health of the islands. Through water security and the development of infrastructure, an increasing number of tourists are travelling to Badu and Moa Islands.

FIGURE 1 Moa Island is the second largest island in the Torres Strait.



ACTIVITIES

IDENTIFY

1 State the vegetation types on Badu and Moa Islands.
2 What is the direction of Saint Pauls from Badu?
3 What is the height of Mt Augustus?
4 Calculate the population density of each of the islands.
5 What are the human features located on these islands?

6 List some of the physical features located on these islands that would appeal to tourists.

EXPLAIN

7 Based on what you can see on the map, how liveable do you think islands are? Support your answer with evidence from the map.

8 Explain, in detail, which of the ***sustainability*** goals impact the liveability of these islands.

PREDICT

9 Identify a combination of human and natural features that might have influenced people to:

- **a** visit the islands as a tourist.
- **b** permanently move to the islands.

10 **a** If you could make these islands more liveable, what would you do?

- **b** Create a list of 5 changes you would make to make them more liveable.
- **c** Provide reasons why you would make these changes and how they would make it more liveable.

FIGURE 2 Topographic map extract of Badu Island and Moa Island in the Torres Strait



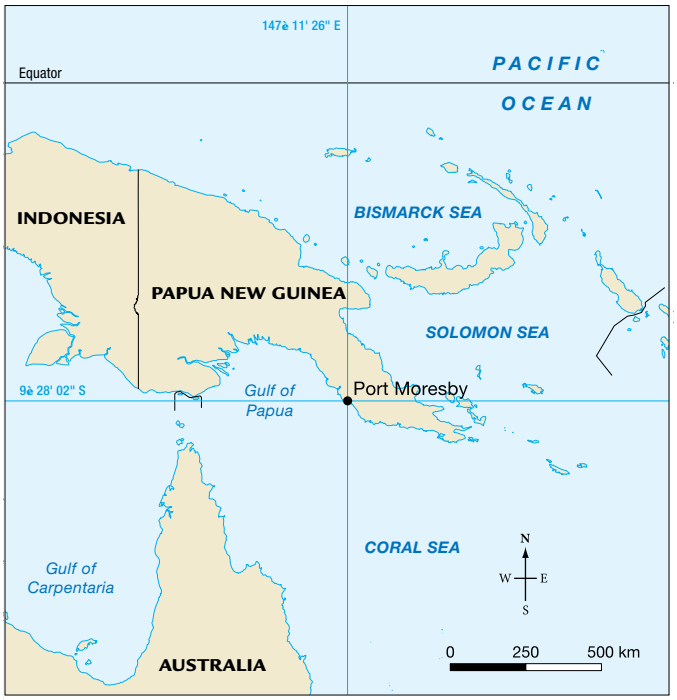
Source: Geoscience Australia.

10.9 Port Moresby — a less liveable city?

10.9.1 Environment

The United Nations measures people's quality of life using the Human Development Index (HDI). In 2000, Papua New Guinea was ranked 133 in the world; in 2013 its ranking had dropped to 157. Its largest city, Port Moresby, is ranked as one of the least liveable cities in the world. The city faces many challenges to meet the needs of its people and improve the standard of living.

FIGURE 1 Location map of Port Moresby



Source: Spatial Vision

Port Moresby, the capital of Papua New Guinea (PNG), is located on the south-eastern coastline. Its population is approximately 350 000, and it is the largest city in PNG.

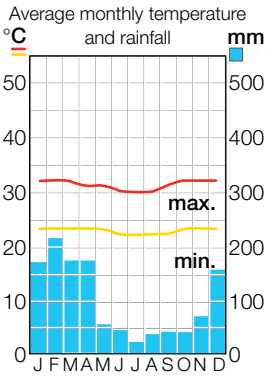
10.9.2 Safety

The crime rate in Port Moresby is very high, and the city has a reputation as one of the most dangerous in the world. Crimes are often very violent, and gang-based crime is common. There are not enough police, and many crimes are never solved. Travellers are advised to be very careful, to not wear obviously expensive jewellery, and to avoid travelling at night.

FIGURE 2 Climate graph for Port Moresby

Temperature is about 30 °C every day. Houses do not need heating.

High temperatures and rainfall encourage plant growth.



Approximately 1000 mm of rain per year

Rainy season can cause landslides.

A distinct dry season can cause water shortages.

10.9.3 Health

The government in Papua New Guinea spends little on preventative measures such as clean water. It also spends little on healthcare. For instance, not all pregnant women can give birth in a hospital, which leads to many complications in childbirth.

FIGURE 3 A ward in Port Moresby Hospital



- Low spending on equipment
- Shortage of medicine
- Not enough doctors and nurses
- Treatable diseases are common.
- Average life expectancy is about 65 years.
- Highest HIV/AIDS infection rate in the Pacific region

10.9.4 Education

School facilities in PNG are quite poor, and attendance rates are very low, particularly for girls. Poor bus services, lack of interest and inability to pay school fees all influence the attendance rate. Only a small proportion of students complete year 12. The **literacy rate** of 55 per cent is quite low by world standards.

literacy rate the proportion of the population aged over 15 who can read and write

10.9.5 Economy

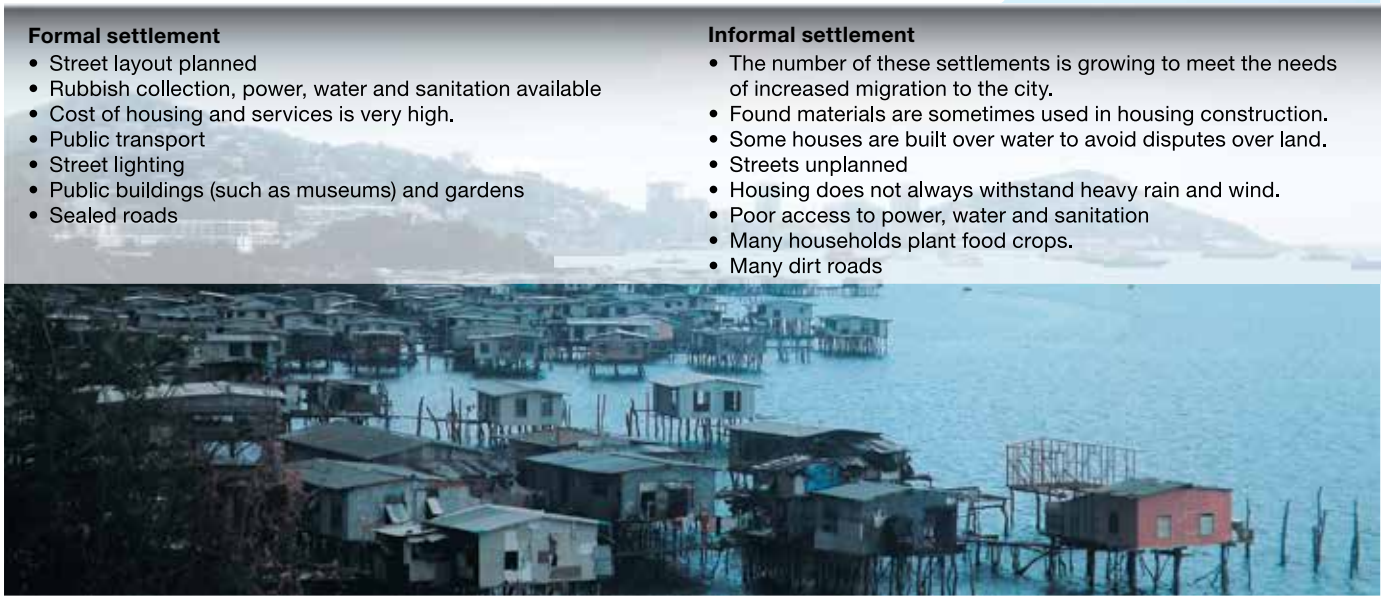
The government in PNG provides no welfare. Fortunately, many families can take advantage of the good growing conditions to produce food to eat and sell. Unemployment is very high, and most work is found in the **informal sector**. Many businesses in this sector involve selling food and other goods. About half the population lives on less than $1 a day.

Life is difficult for girls, and there is much discrimination. Girls do not all get access to school; their literacy rate is lower than that of boys; child-bearing begins at a young age; and the level of violence against women is among the highest in the world.

informal sector jobs that are not officially recognised by the government as official occupations and that are not counted in government statistics

10.9.6 Infrastructure

FIGURE 4 Port Moresby is a mixture of high-rise urbanised landscapes and village landscapes.



ACTIVITIES

IDENTIFY

1 Refer to figure 1. At what latitude is Port Moresby?
2 Why don't all children attend school?
3 In which sector of the economy do most people find work?
4 What do you think is the difference between a formal settlement and an informal settlement?

EXPLAIN

5 How does environmental quality (such as climate) influence living conditions in Port Moresby?
6 Why are travellers advised to be careful in Port Moresby?
7 Refer to figure 3. Which is the biggest health issue facing Port Moresby? Why?
8 Use the **Slum life** weblink in your eBookPLUS to watch a video showing life in slums. Explain how slums are part of the process of city growth.

INVESTIGATE

9 What is the difference between the population of Port Moresby and the biggest city in your state or territory?
10 a Compare the literacy rate in Papua New Guinea and Australia.
b Compare the life expectancy in Papua New Guinea and Australia.

APPLY

11 Use Google Earth to 'fly' to Port Moresby.
a Would you describe the distribution pattern of the buildings as clustered, scattered or linear (in a line)?
b Do you think the distribution of the buildings would make it easier or harder to improve transport, water, power and safety? Justify your answers.

eBookplus

Interactivity
Environmental quality
Use this interactivity to look more closely at how environmental quality affects where people live.
Searchlight ID: int-3096
Weblink
Slum life

eBookplus ONLINE ONLY

10.10 Dhaka — a less liveable city?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

10.11 What makes a place liveable for you?

10.11.1 Liveability studies

A study of a region's liveability will reflect its natural characteristics and human characteristics. All communities would like a safe, healthy and pleasant place to live, a sustainable environment, the chance to earn a liveable wage, reliable infrastructure and opportunities for social interaction.

The findings of a liveability survey will be influenced by a range of factors.

- Where a person lives influences their access to services, employment and environmental features, and their address may influence their perception of the quality of the region.
- Different age groups have different views and needs.
- Current economic conditions influence a person; for example, a major employer may have closed or opened.
- Environmental conditions affect a person; for example, a region may be experiencing drought.
- Government policies influence infrastructure, housing assistance, and grants to local sports clubs.

To find out about the liveability of an area, a number of themes need to be investigated. Some of these can be gained from **census** statistics, while others can be gained only through surveys and fieldwork.

In any community there will usually be agreement about some things that improve liveability. All groups accept that safe water, sealed roads and a reliable power supply are important.

census an official count or survey of a population, which often seeks and records other information about people. The Australian Bureau of Statistics conducts a national census every five years.

FIGURE 1 Community wish list: some aspects of liveability are common to all groups and some are desired by particular groups.

Community wish list

- Playgrounds
- Paths for prams
- Primary schools
- Single-person housing
- Family housing
- Friendly community
- Shopping nearby
- Paths for scooters
- Health services
- Public transport
- Neighbourhood house
- Parks and gardens
- Public seating
- Recognition of those from non-English-speaking backgrounds
- Financial security
- University of the Third Age





If a community wants to obtain certain kinds of items on its liveability 'wish list', it sometimes needs help from national, state or local government. Examples of such items include major roads, railways and desalination plants. Sometimes, though, a wish-list item is best obtained by an individual or community. This is the case when setting up sporting clubs, youth groups and local music events.

TABLE 1 Matching liveability indicators to key themes

Measure	Examples of indicators	
Social	• Population characteristics (gender, age) • Education (primary, secondary, tertiary) • Health (life expectancy, health-centre attendance, length of walking tracks, smoking rates, weight, chronic diseases) • Safety (perception, crime rates, road deaths and injuries, work safety)	• Volunteering • Voting • Aged care accommodation • Access to public transport • Membership of clubs and organisations • Diversity (ethnicity)
Environmental	• Biodiversity • Planning for the future • Water access • Waste management • Ecological footprint	• Public spaces • Household recycling • Weather • Land clearing
Economic	• Employment • Variety of businesses • Income • Financial stress • Housing types	• House ownership • Infrastructure • Internet access • Power • Car ownership

collate to organise the findings of fieldwork

FOCUS ON FIELDWORK

Looking at your school environment

Geographers are particularly interested in:

- the location of things
- the distance between things
- the distribution patterns we can see when we produce a map
- the movement between places
- the connection between places
- the changes that happen over time.

How can you apply these concepts when finding ways of improving your school environment? Work in pairs to gather the data needed for the following fieldwork task. Each student will complete a report of findings.

Step 1: Study the distribution of resources and landscapes over space in the schoolyard.

- Obtain an outline map of the schoolyard.
- Walk around the schoolyard and identify different categories of land use. Design a key for your map and mark in the land uses on your map.
- As you walk around the schoolyard, also note the landscape (slopes, swamp, bare ground, concrete and so on). Record the information about the landscape on your map. You may add to your key or annotate the map. You may also wish to use an overlay. (See SkillBuilder 10.12 'Creating and analysing overlay maps'.) You could also add images.
- Describe the distribution of land uses in the schoolyard. Can you identify regions? Mark these on your map. Consider using an overlay. Is there any interconnection between the landscape and land use?

Step 2: Study the patterns of movement in the schoolyard.

- Choose two places that students often walk past.
- Record the number of students who pass and the direction of travel in two five-minute sessions.
- Add this information to your map. Which are the busiest walkways in the schoolyard?

Step 3: Make recommendations for improvements to the schoolyard.

Based on the information you have gathered, describe:

- pleasing aspects of the schoolyard
- disappointing aspects of the schoolyard
- your three most effective suggestions for improving the schoolyard.

Mark the location of the proposed changes on your map. You may include images of proposed changes.

Conduct a short survey of ten other students to find out what they think about your three suggestions for improving the schoolyard.

When conducting your survey, there are three types of questions you need to ask: those that seek an opinion, those that seek a fact and those that seek a suggestion.

- To seek opinions, try to ask for a rating. For example, *There should be more seats in the schoolyard. Do you (a) strongly disagree? (b) disagree? (c) neither agree nor disagree? (d) agree? (e) strongly agree?*
- To seek facts, ask for a structured response. For example, *How often do you use the seating by the oval? (a) Every day (b) 1–3 times a week (c) A few times a month (d) A few times a year (e) Almost never.*
- To seek suggestions, use open-ended questions. For example, *What sorts of plants do you think should be planted along the front fence?*

Create one question for each of your suggestions. Cover each type of question. Ensure you have your map with you when you ask the questions.

Collate, or gather, the survey data for each question. For each question, count the number of responses that are the same, and present the result in words, in a table or in a graph. (You might choose a bar graph, for example. See SkillBuilder 15.6 'Creating a simple column or bar graph'.) There might be a clear trend in the responses or there might be variety in the responses.

To what extent do your survey findings support your suggestions? Describe the result.

ACTIVITIES

IDENTIFY

1 What are the three themes used when investigating liveability? Why do you think these are chosen?

EXPLAIN

2 Refer to table 1 and identify two aspects that could be placed in a different theme. Justify your suggested change. Suggest one more indicator that should be included. Into which theme would it belong?

3 Refer to figure 1 and use an organiser like a Venn diagram to compare and contrast the liveability wish lists for young families and older people.

INVESTIGATE

4 Find a local news story about a change to liveability in your area. Is the ***change*** economic, social or environmental? Is the ***change*** predicted to be positive or negative? Will the ***change*** be permanent?

APPLY

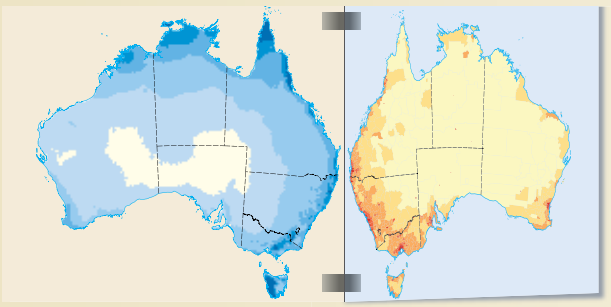
5 How could the improvement in liveability for one age group actually help the liveability of another age group? Provide an example.

eBook*plus* ONLINE ONLY

10.12 SkillBuilder: Creating and analysing overlay maps

What are overlay maps?

An overlay map usually consists of two or more maps of the same area. A base map is overlaid with a transparent overlay, showing different information. Overlay maps allow users to see the relationships between the information on two or more maps.



eLesson

Watch this video to learn how to create and analyse an overlay map.



Searchlight ID: eles-1645

Interactivity

Try this interactivity to learn how to create and analyse an overlay map.



Searchlight ID: int-3141

10.13 How could my community be made more liveable?

10.13.1 Transport strategies

People in towns and cities are always looking for strategies to improve their living conditions. A community is made up of people from a range of age groups, a number of different land uses, a range of needs and a variety of interests. Ideas and plans for improvement may be overarching or targeted.

The movement of people within and between neighbourhoods is an important issue in towns and cities. The humble bicycle is now seen as a way of increasing mobility, reducing traffic congestion, reducing air pollution and boosting health. Bicycle tracks encourage recreational riding for all ages (see figure 1) and dedicated bicycle paths along main routes (see figure 2) encourage people to **commute** by bicycle, rather than car, to work and school.

commute to regularly make a journey such as from home to work

FIGURE 1 Recreational riding along a trail mainly designed for bicycles



In 1965, a group in Amsterdam, the Netherlands, introduced the idea of bike sharing — public bicycles that are hired, usually for short trips. This first attempt was not a success, but the idea persisted. Modern bike-sharing systems have overcome problems of theft and vandalism by using easily identifiable specialty bicycles, monitoring the bicycles' locations with radio frequency or GPS, and requiring credit-card payment or smart-card-based membership to check out bicycles. In some places, bicycles can be located on your mobile phone, and there are more links between bicycles and existing public transport. Today there are more than 500 cities in 49 countries that have bike-sharing programs, with a combined fleet of over 500 000 bicycles. Bike-sharing programs are an example of a popular strategy that is aimed at improving liveability for a range of ages and locations within a community.

An example of a successful bike-sharing scheme is in Paris. The Vélib was introduced in 2007 and quickly doubled in size. By 2012, bicycle trips in the city had grown by 41 per cent. Bike sharing is part of a plan to reduce car traffic and pollution in Paris, which includes closing streets to cars on weekends, reducing speed limits, encouraging bus travel and extending bicycle lanes.



FIGURE 2 Special bicycle lanes increase the safety of bike riding.

Research task

Liveability in my community

1 Identify a ***space*** in your neighbourhood that you think could be improved for teenagers. It may be one that is currently attractive, or it may be a least favourite ***space***.
2 Provide an image (photograph, diagram or map) of this ***space***. Annotate the image to describe its current characteristics. Also, state what the space is used for.
3 Identify the key concerns about this ***space***. You might think about safety, tolerance, ***sustainability***, access, inclusiveness, services, ***environmental*** quality, health and respect.
4 How would you improve this ***space***? Provide a suggestion to address each of your concerns.
5 Provide a new image to show the impact of your proposals. This could be a diagram, sketch, annotated photograph, model or whatever helps communicate what the impacts might be.
6 Which are your two most important suggestions? What criteria did you use to choose these suggestions? Which suggestion is most likely to be implemented? Why?
7 Create a short survey to show 10 people your idea about the improved space. Record your data in a series of pie charts.

FIGURE 3 Barangaroo is a 22-hectare waterfront renewal project on the western Harbour foreshore of Sydney's CBD near Darling Harbour. This was once one of Sydney's oldest industrial sites. This area has been designed to enhance the wellbeing of the community. It aims to:

- be carbon-neutral by generating solar renewable energy on site for the public areas
- provide recycled water from Barangaroo to the CBD
- use recycled water for flushing toilets, irrigation and fire sprinklers
- generate zero waste
- provide access to and facilities for walking, cycling and recreation, including a 2.2 kilometre foreshore walk.

More than 50 per cent of Barangaroo will be public space.



FIGURE 4 Melbourne's City Square, bordered by Swanston and Collins Streets, Flinders Lane and the Westin Hotel, has been designed as a liveable multi-use outdoor space. Trees have been planted to provide shade, accessible tram stops built, cafes established, and bins, grassed areas and seating provided for locals and visitors.



ACTIVITIES

IDENTIFY

1 What are three advantages of increasing bicycle riding?
2 What problems were faced by the first bike-sharing scheme?

EXPLAIN

3 Use the **Bike sharing** weblink in your eBookPLUS and scroll down to the link '(See data.)'. This will take you to an Excel document. Use this document to answer the following questions.
   a In 2012, how many bike-sharing programs were there in each of these regions?
      • Asia–Pacific
      • Europe
      • Latin America
      • Middle East
      • North America
   b Name at least two countries with bike-sharing programs in each of these regions.
   c Which region has the most programs?
   d Which region has had programs for the longest period of time?
   e Which region has introduced programs most recently?
   f Which region has the greatest number of bicycles? Is this the same region that has the greatest number of programs?
   g Explain how you could present data about bike-sharing programs on a map. Provide examples of how you would show:
      • countries with programs
      • the number of programs per country
      • the number of bicycles per country.

INVESTIGATE

4 Find out about a bike-sharing scheme in Australia or overseas. Describe its location and the region it covers. Provide three other key facts about the scheme.

eBookplus
Weblink
Bike sharing

eBookplus ONLINE ONLY

10.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

10.4 SkillBuilder: Drawing a climate graph

10.4.1 Tell me

What are climate graphs?

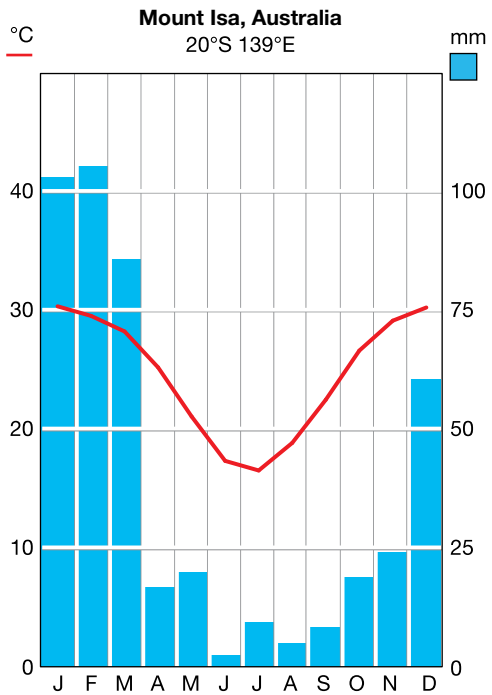
Climate graphs, or climographs, are graphs that show climate data for a particular place. They combine a column graph and a line graph. The line graph always shows average monthly temperature, and the column graph always shows average monthly precipitation (rainfall). Temperature can be shown in one line, as mean monthly temperature; or it can be shown in two lines, as maximum and minimum monthly temperature.

Why are climate graphs useful?

Climate graphs are used to show the climate of a place over a 12-month period. As the red line on the graph shows temperature and the blue columns show rainfall, you can quickly understand the graph. It is much easier to compare the climate of two places by looking at climate graphs than by looking at tables of statistics, so drawing and using these graphs is an important geographical skill. It also makes it very easy to compare climate patterns for different areas when the graphs are drawn using the same conventions. The left-hand axis represents temperature and the right-hand axis represents rainfall, so you must take care to read from the correct scale when interpreting a climate graph.

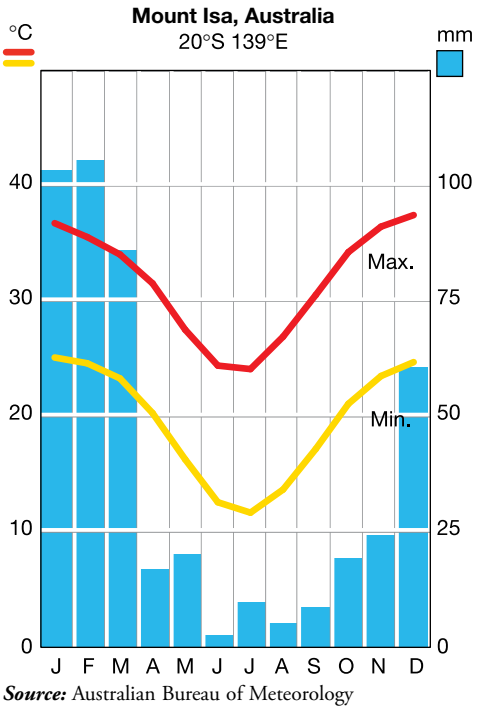
Mount Isa is located in the arid Gulf Country region of Queensland. It has some of the world's richest deposits of copper, silver and zinc. It is one of the largest centres in outback Australia. Most of the population of nearly 23 000 people are involved in mining. In the climate graphs in figures 1 and 2, you can see how one or two temperature lines can be used to give us an understanding of the climate.

FIGURE 1 Climate graph for Mount Isa, Queensland



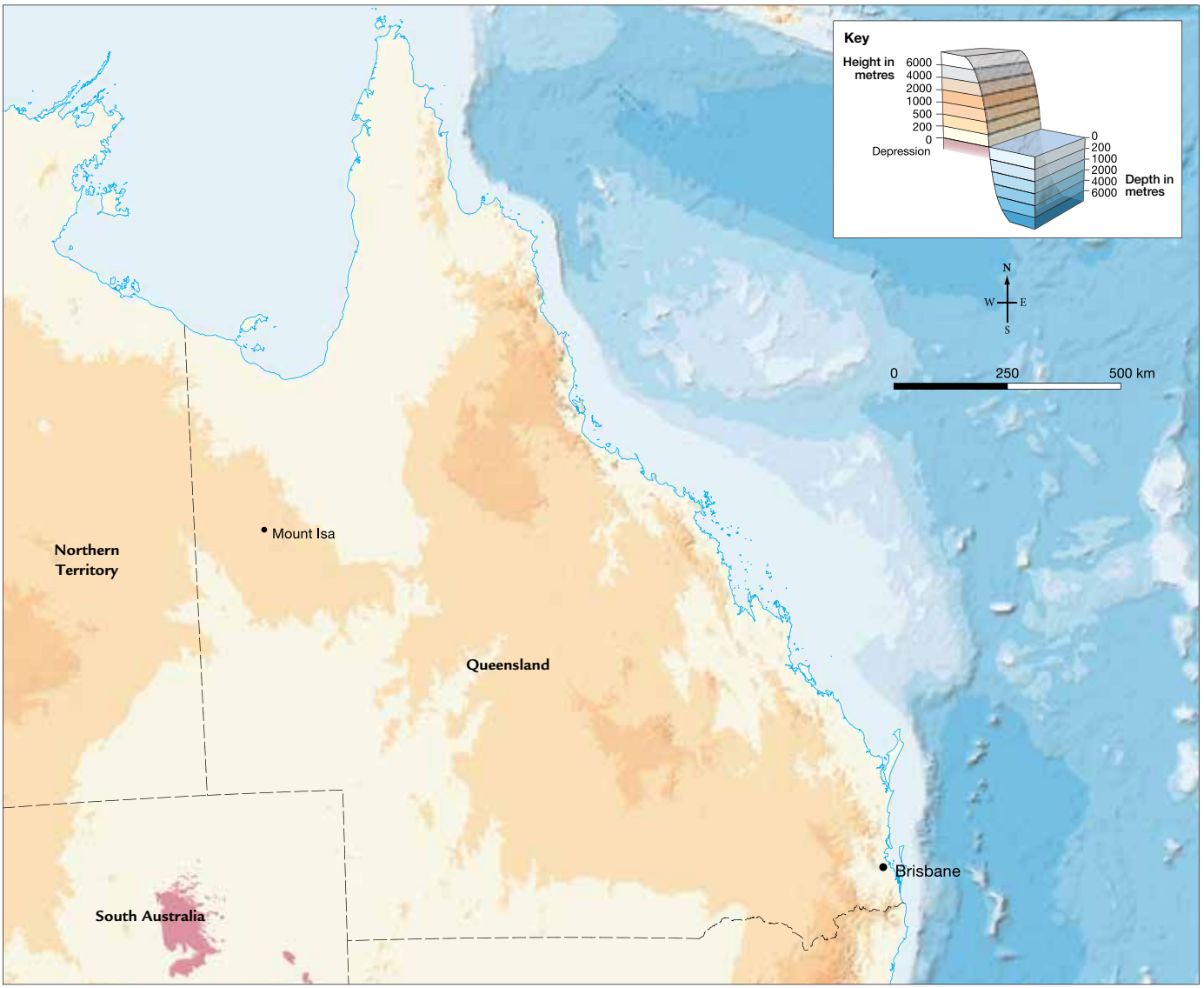
Source: Australian Bureau of Meteorology

FIGURE 2 Climate graph for Mount Isa, showing maximum and minimum temperature averages



Source: Australian Bureau of Meteorology

FIGURE 3 Location of Mount Isa



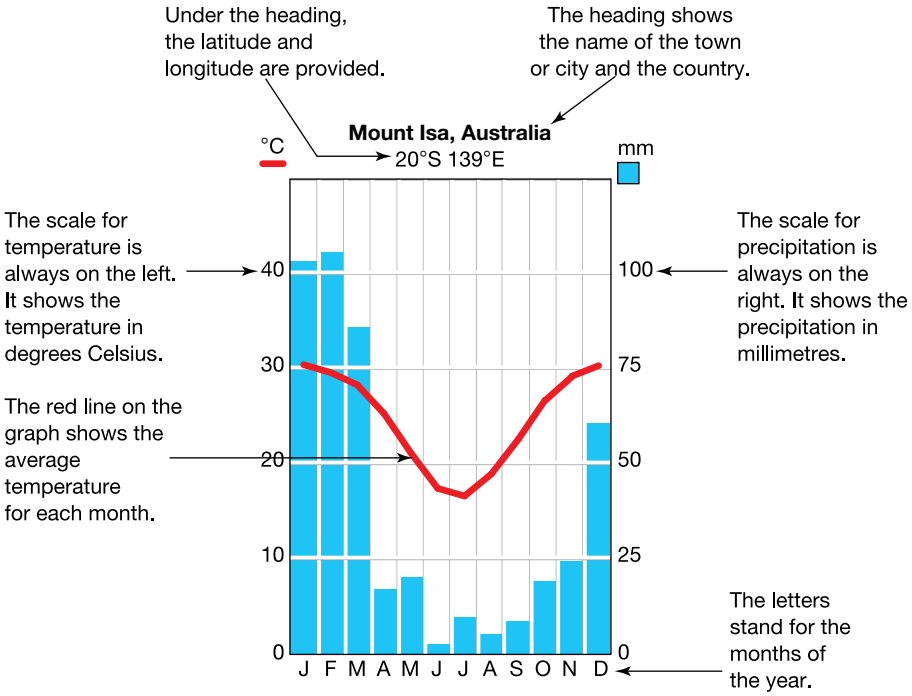
Source: Spatial Vision

Model

A good climate graph:

- is drawn in pencil first, and then coloured
- has ruled axes
- has labelled axes
- makes use of small dots before a line is drawn
- has a smooth curve for the line in red
- has columns shaded in blue
- includes a title
- includes a source.

FIGURE 4 Features of a climate graph



10.4.2 Show me

How to complete a climate graph

You will need:

- data to plot on your graph
- graph paper
- a grey lead pencil
- a ruler
- a red pen and a blue pencil.

eBookplus

eLesson
Drawing a climate graph
Searchlight ID: eles-1644

Procedure:

To complete a climate graph, you must have data for the place of interest. If you need to find data, use the **World climate** weblink in the Resources tab for locations outside Australia, and use the **Bureau of Meteorology** weblink for Australian locations.

STEP 1

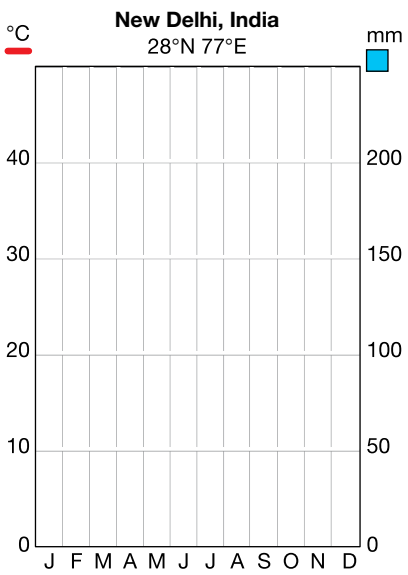
Look at the data in the table below. Two sets of data are given: average monthly precipitation and average monthly temperature.

TABLE 1 New Delhi, 28°N 77°E, average monthly precipitation and average monthly temperature

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
°C	14.1	16.9	22.4	28.6	32.8	33.8	31.0	29.8	29.2	26.0	20.3	15.4
mm	22.7	20.1	14.5	10.1	15.0	67.9	200.4	200.3	122.5	18.5	3.0	10.0

Source: www.worldclimate.com

FIGURE 5 Set of axes for New Delhi



STEP 2

Consider the range of the data before you decide what scales will work for the vertical axes. For the right-hand axis, find the wettest month. The precipitation scale begins at 0 and extends far enough to include the wettest month. For the left-hand axis, find the highest and lowest temperatures. A scale of 0°C to 40°C will suit most climate graphs. Try to use temperature and precipitation scales that prevent the line and column graphs from overlapping; however, this may not be possible if the place has a very high rainfall.

STEP 3

Use a ruler and pencil to draw the axes on graph paper. Divide the horizontal axis into 12 equal sections to represent the months of the year. Label each month. Label the temperatures on the left vertical axis and precipitation on the right vertical axis.

STEP 4

Construct a column graph showing the average monthly rainfall for New Delhi. Make sure you use the right-hand vertical scale to plot your data. Rule a line across each column and colour the column blue.

STEP 5

Construct a line graph showing the average monthly temperature for New Delhi. Plot the temperature by placing a dot in the centre of each month. Make sure that you use the left-hand vertical scale. Use a red pen to join the dots with a smooth curve; don't use a ruler.

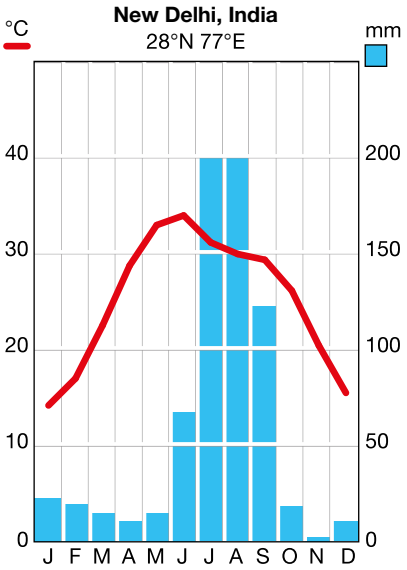
STEP 6

Add a title, giving the name of the place, the country and the latitude and longitude. You can also show the elevation if you wish.

STEP 7

Add the source of your data.

FIGURE 6 New Delhi, climate graph



eBook*plus*

Interactivity
Drawing a climate graph
Searchlight ID: int-3140

10.4.3 Let me do it

Developing my skills

Use the data in the table below, or select data using the **World climate** weblink in the Resources tab for a place that is relevant to your studies in Geography, to draw a climate graph.

TABLE 2 Mount Buller, Victoria, 37.15°S, 146.44°E, elevation 1707 m, average monthly precipitation and average monthly temperature

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
°C	17.2	16.5	14.4	10.0	6.2	3.0	1.4	2.0	4.9	8.2	11.8	14.3
mm	59.0	68.0	44.8	76.1	110.0	154.2	161.0	145.6	143.0	110.6	126.8	84.3

Source: Australian Bureau of Meteorology

Questions

Mount Buller is a mountain in the Australian Alps. It is three hours' drive from Melbourne, and is the closest major mountain to Melbourne for skiing in winter.

1. Which month is warmest in Mount Buller?
2. Which month is coolest in Mount Buller?
3. Which month has the greatest precipitation in Mount Buller?
4. Which month has the least precipitation in Mount Buller?
5. Describe the climate of Mount Buller.

Checklist

I have:

- ruled the axes and labelled them
- drawn first in lead pencil and then used colour
- used small dots for the lines and then created a smooth curve with red pen
- shaded the columns in blue
- included a title and source.

Skills questions

1. Choose the correct answer. Climate graphs are used to show:
   a. temperature and wind
   b. the shape of the land
   c. total hours of sunlight
   d. precipitation and temperature.
2. Choose the correct answer. When a climate graph includes two lines, they represent:
   a. wind and rain
   b. minimum and maximum temperatures
   c. rainfall for the past two years
   d. wind and temperature.
3. Why might blue have been chosen as the conventional colour for showing precipitation?
4. Why don't we draw one climate graph for a whole country, such as Australia?

eBook*plus*

Weblinks

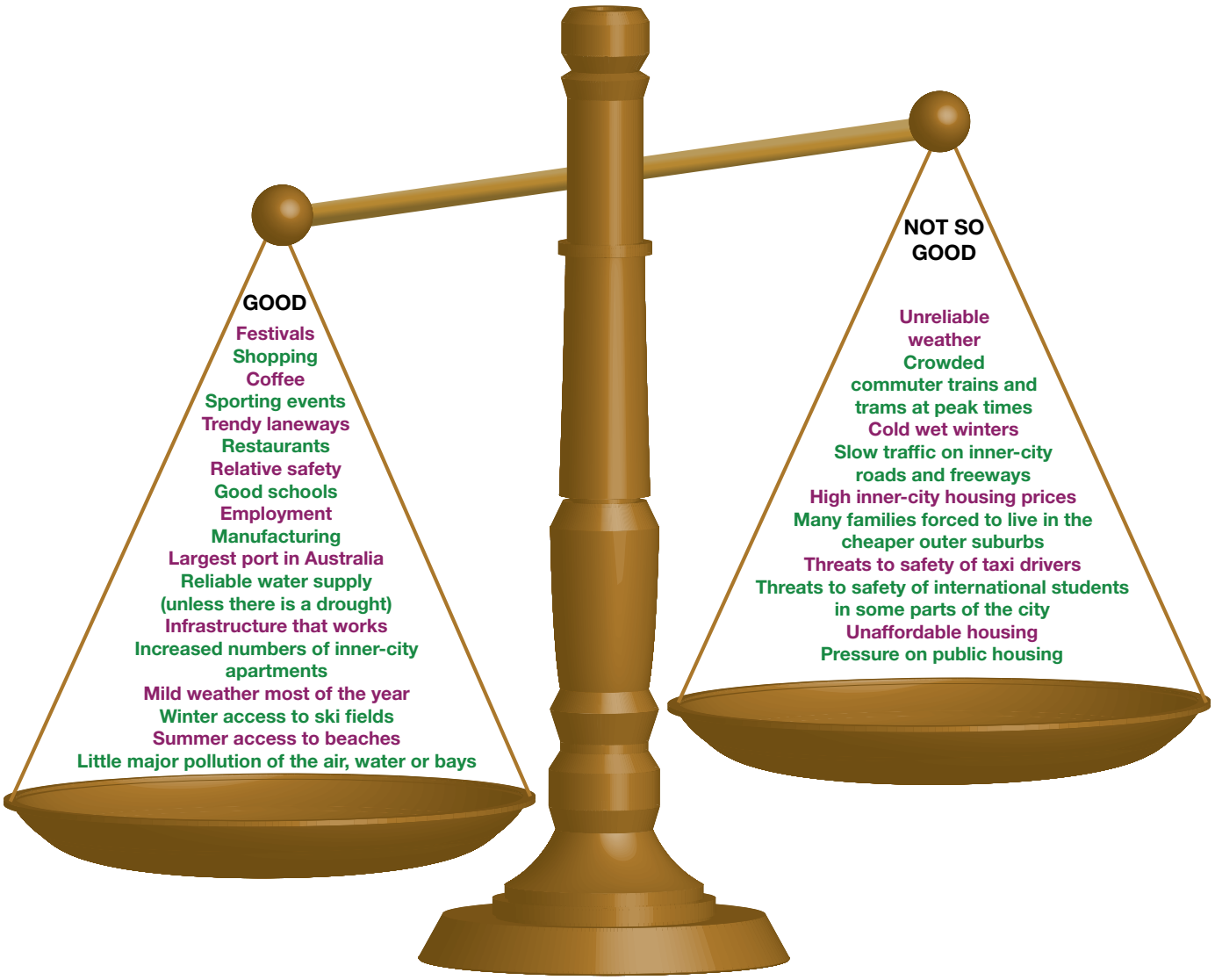
- Bureau of Meteorology
- World climate

10.6 What makes Melbourne the world's most liveable city?

10.6.1 What is Melbourne like?

What makes Melbourne such a liveable city? Use the **Melbourne view** weblink in the Resources tab to listen to why it was voted the world's most liveable city. Think about whether or not Melbourne is a 'perfect' city. Saying that a city is the 'most liveable' gives it a ranking, like those given to cars or restaurants. The criteria that are used for the selection process may change, though. In 2015 it was best, but why?

FIGURE 1 The balance of good features and not-so-good features



10.6.2 Is all of Melbourne the same?

Within the most liveable city, there are some parts that are more liveable than others. People may have higher incomes, larger houses, more and better cars, a view of the sea or the Yarra River, and better shops and entertainment facilities. This does not mean that the highly liveable inner eastern and southern suburbs do not have pockets of poorer housing and homelessness; it is just that they have fewer of them.

Like most large cities, Melbourne is known for its regions. There is a north–south divide, with the Yarra River acting as the boundary, and an east–west divide, with the CBD as its boundary. The west is predominantly flat, dry land, with cheaper housing and land values. The south and east are the leafy suburbs with bayside and hill views, more expensive land and larger houses. The inner north is quite trendy, and more expensive than the west. But the outer suburbs, in all directions, are less well serviced by infrastructure. These areas have huge new suburbs full of large houses on smallish blocks, which are much cheaper than anything close to the centre of the city.

FIGURE 2 (a) Central Melbourne — the Yarra River, parkland, sporting facilities and central business district (b) Melbourne tram (c) Modern office buildings (d) Graffiti in Hosier Lane (e) Outer suburban area of South Morang (f) Studley Park, not far from the city centre

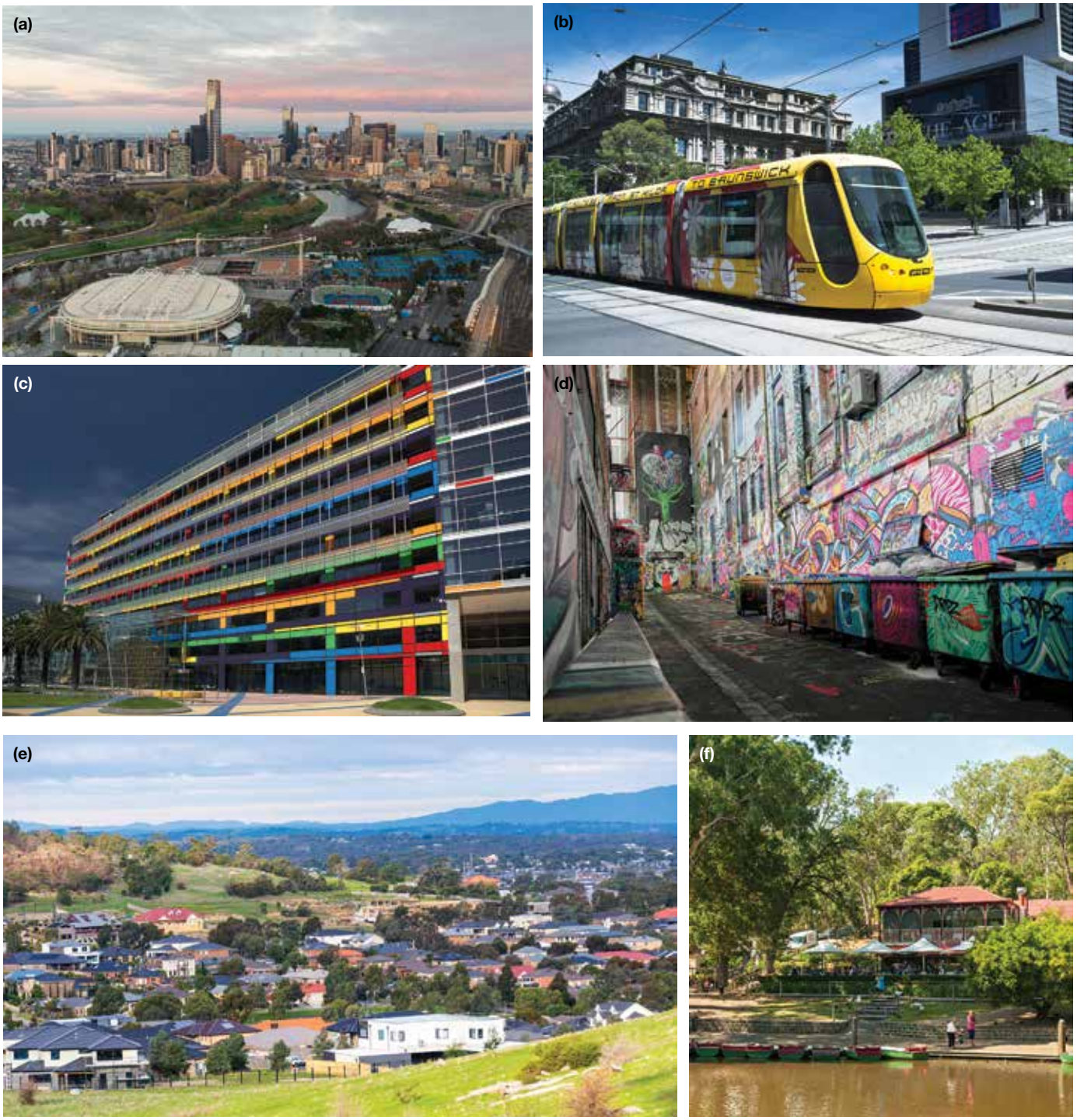


FIGURE 3 Promotion for Melbourne



ACTIVITIES

IDENTIFY

1 What are two ways of describing the weather in Melbourne?

2 What is the city's traffic like during peak times?

3 a What is the difference between the landforms in Melbourne's east and west?

b What is the difference in rainfall between Melbourne's east and west?

EXPLAIN

4 View a video about Melbourne being ranked the world's most liveable city using the **Melbourne view** weblink in the Resources tab. Do you think the filmmaker believes that Melbourne really deserves its number one ranking? Explain your answer with reference to the content of the clip.

5 Look at the images of Melbourne in figure 2. List 10 liveability factors that these images illustrate.

PREDICT

6 Which of Melbourne's not-so-good features may have an impact on whether it remains the world's most liveable city?

INVESTIGATE

7 Which Australian city do you live in, live closest to or know best? Write a summary of it, similar to that provided in figure 1. Can you identify any major differences between your city and Melbourne?

8 Why do you think that four of Australia's major cities are ranked in the world's top 10?

eBook*plus*

Weblink
Melbourne view

10.10 Dhaka — a less liveable city?

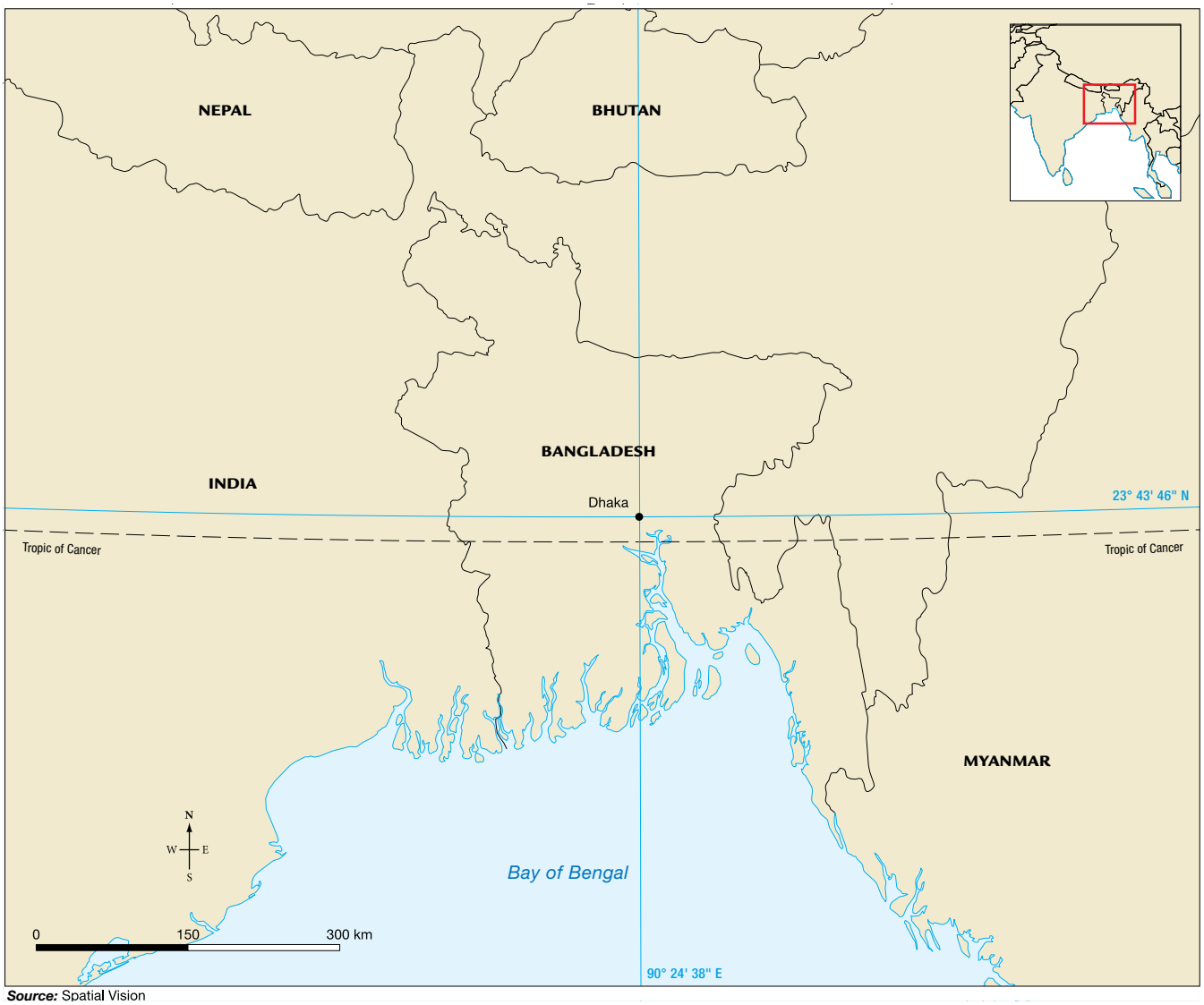
10.10.1 Dhaka

Some regions of Dhaka are similar to Australian suburban areas, with solid housing structures, shopping centres, high car ownership, and high expenditure on cars, household possessions, personal services and technology. However, it is the incidence of poverty and unplanned urban growth that leads to the city being ranked as one of the least liveable in the world.

Environment

Dhaka is the capital city of Bangladesh. It is located in Asia at latitude 23.43°N.

FIGURE 1 Location of Dhaka



Source: Spatial Vision

As you can see in figure 2:

- there is a distinct dry season
- eighty per cent of rain falls in the wet season (the monsoon)
- it is often hot and humid
- approximately 2000 mm of rain falls per year
- it is warm to hot all year.

FIGURE 2 Climate graph for Dhaka

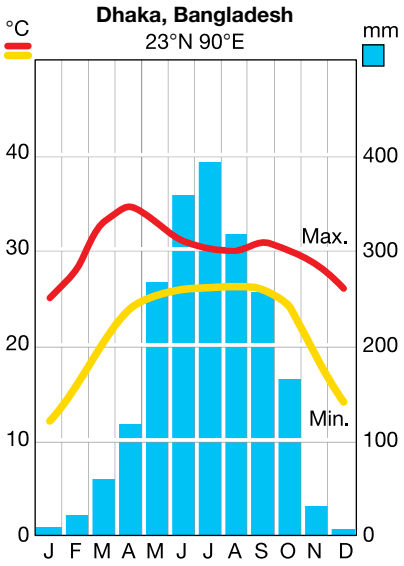


TABLE 1 Humidity levels in Dhaka

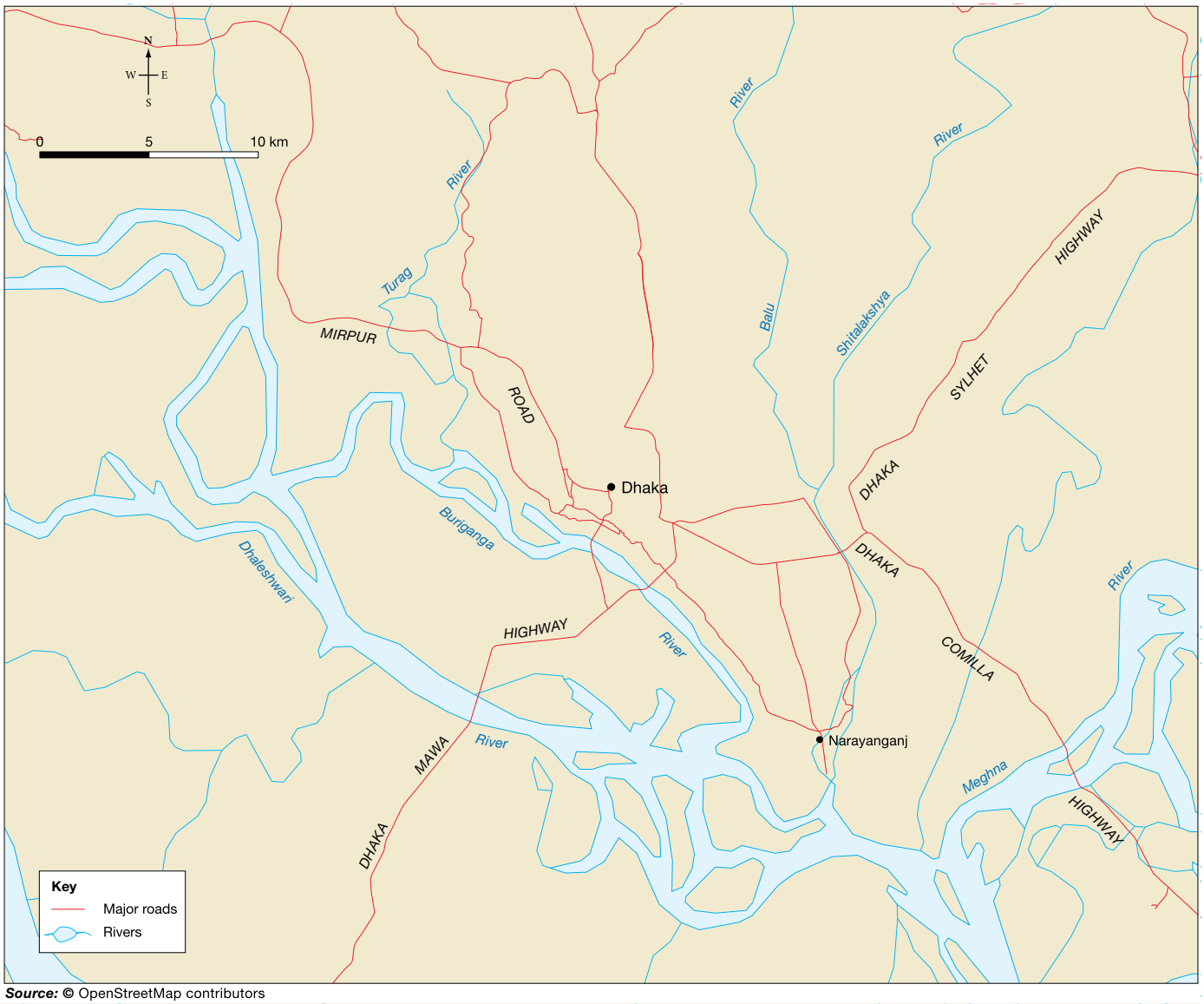
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Humidity (%)	54	50	45	56	72	80	80	79	79	73	67	64

Dhaka is only 2–13 metres above sea level. Snow-melt from the Himalayas feeds the rivers. This area is at high risk from climate change. Any increase in snow- and ice-melt or rainfall will add to river flow. There are many rivers that flow near Dhaka. There is a high risk of flooding. During the monsoon, there are often strong winds, which also cause damage.

Infrastructure

The population of Dhaka is more than 15 million, and it is growing by about 400 000 every year. People migrate to the city in the hope of finding work in the growing industrial sector. The huge influx of people has led to unplanned urban growth on vacant land, and about half the population live in slums. This has created one of the most densely populated cities in the world. Because people can be evicted from the slum areas by landowners, the government does not provide infrastructure.

FIGURE 3 Map showing the many rivers that flow through and around Dhaka

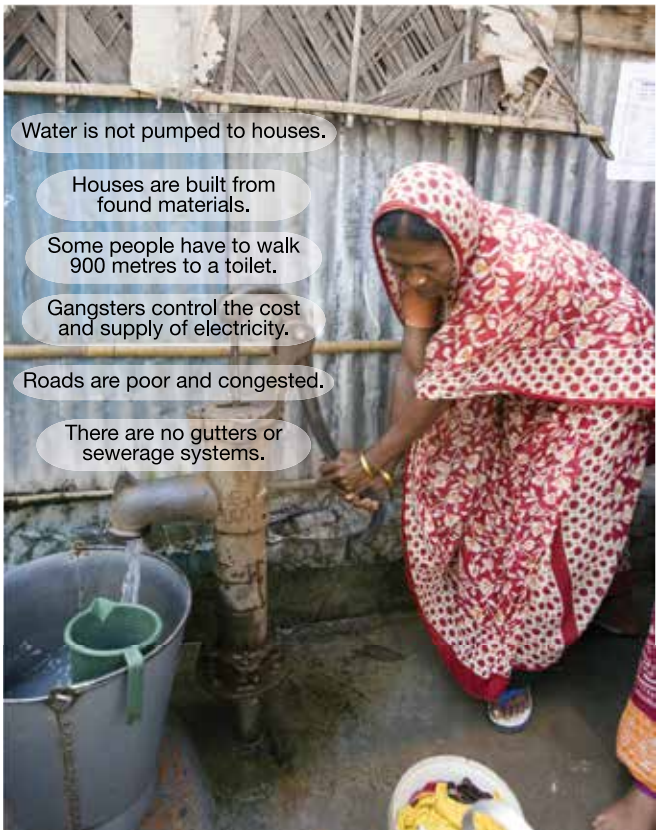


Source: © OpenStreetMap contributors

FIGURE 4 This woman has to walk through floodwaters to collect drinking water. Poor areas have no drainage, and floodwater quickly spreads into houses and over paths.



FIGURE 5 A communal water pump in a slum region



Safety

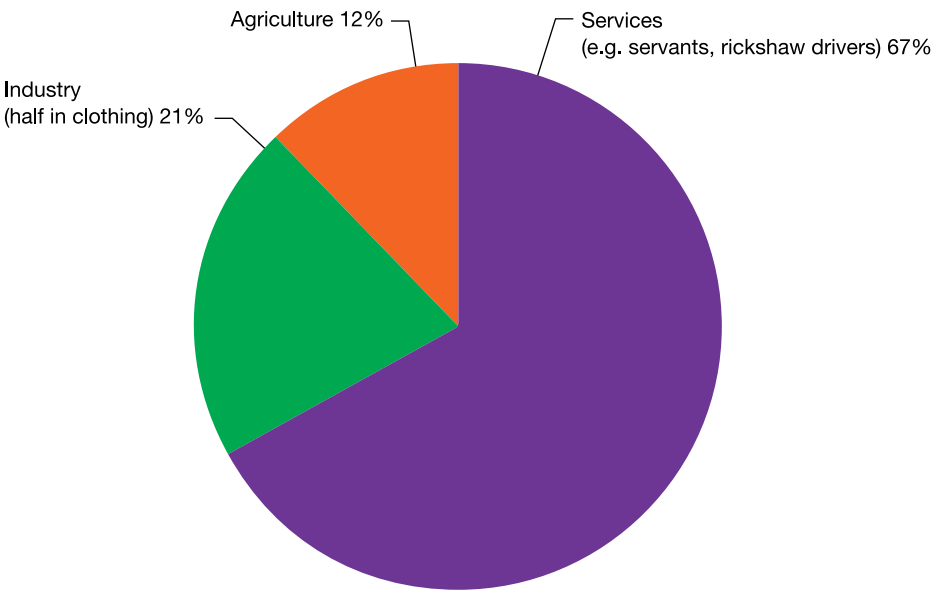
Crime rates are high in the poor areas of Dhaka. There is gangster violence; land grabbing; violence against women and children; arson; and crimes related to gambling, drugs, alcohol and illegal weapons. There are not enough police officers, and they cannot be relied on to protect citizens.

Education

Primary education is compulsory but the government is unable to provide enough schools and resources for the increasing population. Many students do not attend school all the time because their families need them to earn money. In spite of the tough conditions, the education rate in the city is slightly higher than in rural areas, and the national **literacy rate** is about 70 per cent.

literacy rate the proportion of the population aged over 15 who can read and write

FIGURE 6 Employment of Dhaka poor



Economy

Most jobs are found in the informal sector; examples include rickshaw driver, street vendor and garment worker. Women are excluded from trades and transport, and most find work as servants or in agriculture. (Food is grown on vacant land within and around the city.) The pay in these types of jobs is low, and

most or all household members need to work. Child labour is common; 20 per cent of children aged under 15 are working. About 30 per cent of the urban population is poor, and many live on $1 a day. Even with these disadvantages, many people think the city offers a better quality of life than the rural areas do.

Healthcare

Healthcare is mainly provided through hospitals, which are located in the **formal** part of the city. There is a shortage of hospital beds, equipment, doctors and nurses. There are no medical facilities in the slums, and often families cannot afford to pay for treatment. Private charity groups do offer some programs, particularly for maternal health.

FIGURE 7 Children as young as seven undertake exhausting work. This child is earning $1 a day.



eBook*plus*

Interactivity
Safe as houses
Searchlight ID: int-3097

formal describes an event or venue that is organised or structured

ACTIVITIES

INVESTIGATE

1 In which continent is Dhaka?
2 When is the monsoon season in Dhaka?

EXPLAIN

3 How does the natural ***environment*** influence life in Dhaka?
4 How is life in the Dhaka slums affected by the lack of resources that are normally provided by government, such as water, healthcare, education and safety?
5 Why do very young children go into the workforce?
6 Why does Dhaka continue to grow even though it rates poorly in terms of liveability?

PREDICT

7 Compare the population of Dhaka with the population of Australia.
8 The population density of Dhaka is approximately 40 000 people per square kilometre. Select one square kilometre of a residential region near your school. Estimate the number of people who live in that ***space***.

APPLY

9 Choose one of the other least liveable cities (see section 10.3.2) and find out how the natural environment creates challenges and provides benefits there. Consider the city's location, climate and landscape.

10.12 SkillBuilder: Creating and analysing overlay maps

10.12.1 Tell me

What are overlay maps?

An overlay map usually consists of two or more maps of the same area. These maps are drawn at the same size or scale but show different information. The base map often shows information that does not change very much. Another transparent overlay, showing different information, is laid over the base map.

Why are overlay maps useful?

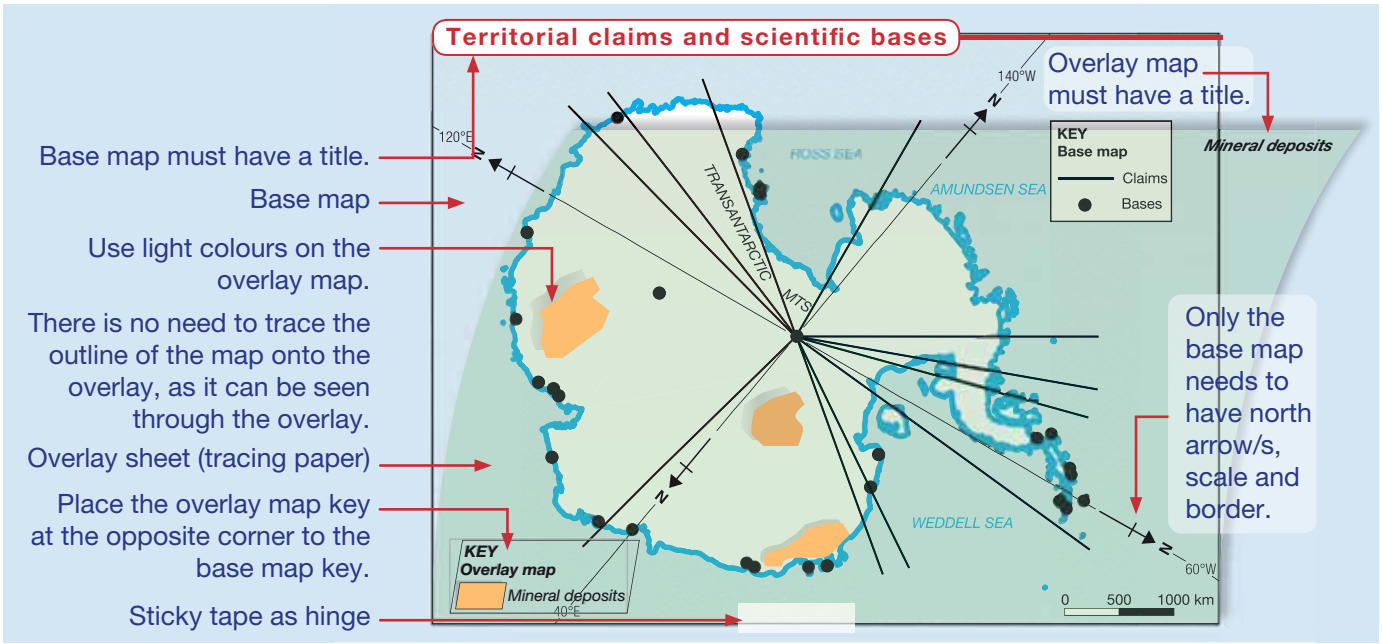
An overlay map is useful for comparing two different features on a map. It is really two maps in one — a base map drawn on paper and an overlay drawn on tracing paper to depict additional information.

Overlay maps allow map users to see the relationships between the information on two or more maps. They are useful when looking for patterns of spatial association — that is, features found in a similar distribution pattern.

Model

In this overlay map, the base map depicts the continent of Antarctica, territorial claims and scientific bases. The overlay illustrates mineral deposits.

FIGURE 1 Constructing an overlay map of mineral deposits in Antarctica



A good overlay map:

- is drawn in pencil first, with colour added later
- includes BOLTSS on the base map
- uses light colours on the overlay so the base map information is visible
- includes a key for the element depicted on the overlay
- is hinged to the base map using sticky tape
- includes a title for the overlay.

eBook*plus*

eLesson
Creating and analysing overlay maps
Searchlight ID: eles-1645

10.12.2 Show me

How to complete a overlay map

You will need:

- two or more maps of the same area, drawn at the same scale and showing different information
- tracing paper
- cardboard (optional)
- clear adhesive tape
- a black lead pencil
- coloured pencils.

Procedure:

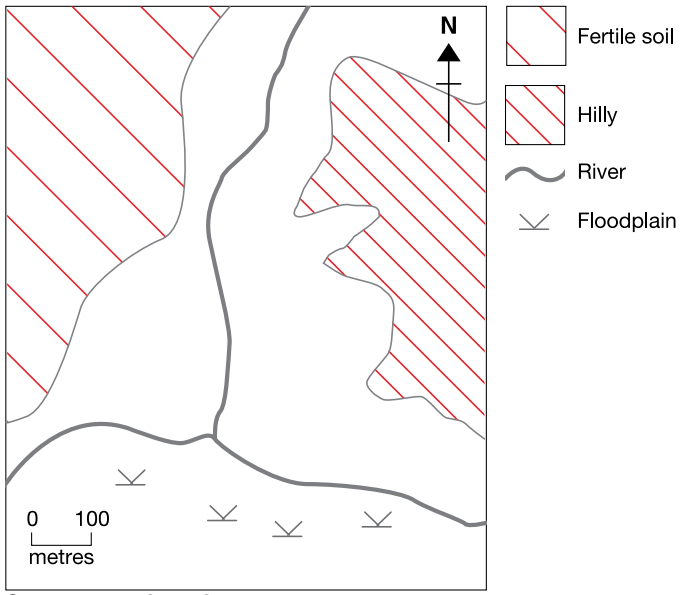
STEP 1

Create a base map of an area showing the distribution of features you are interested in displaying (figure 2). Base maps are drawn on clean white paper. To make a base map, you find a map of the area that you want to show, and trace the features that are relevant to your purposes. Ensure you include BOLTSS.

STEP 2

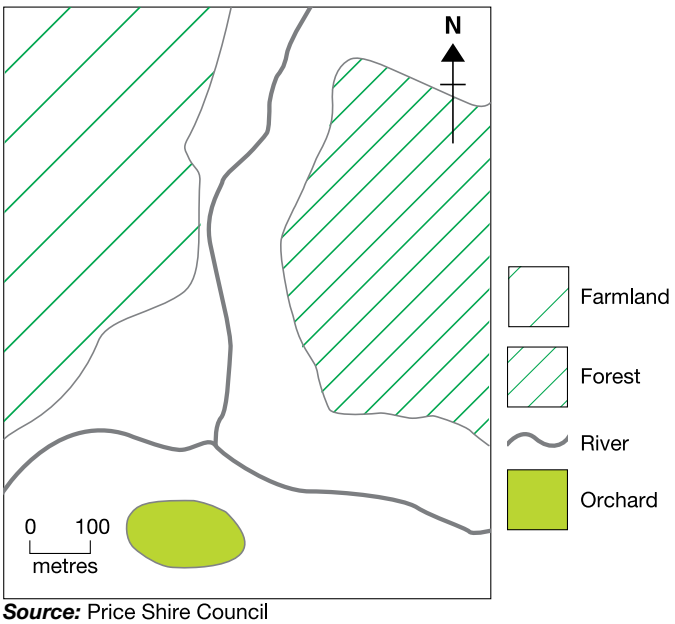
Create an overlay of a second feature on the tracing paper (figure 3). (*Hint:* Make sure the second map is of exactly the same area and is drawn to the same scale and size as the base map.)

FIGURE 2 The fictional Price Shire



Source: Price Shire Council

FIGURE 3 Land use in Price Shire



Source: Price Shire Council

STEP 3

Join the base map and the overlay together using adhesive tape (figures 4 and 5). Before doing so, check that key features such as coastlines and major roads line up on both maps. You may wish to attach your base map to some cardboard to make it more durable. You can create more than one overlay, each depicting a different feature. If you do this, you can hinge each overlay from a different side of the base map.

FIGURE 4 Place the overlay onto the base map

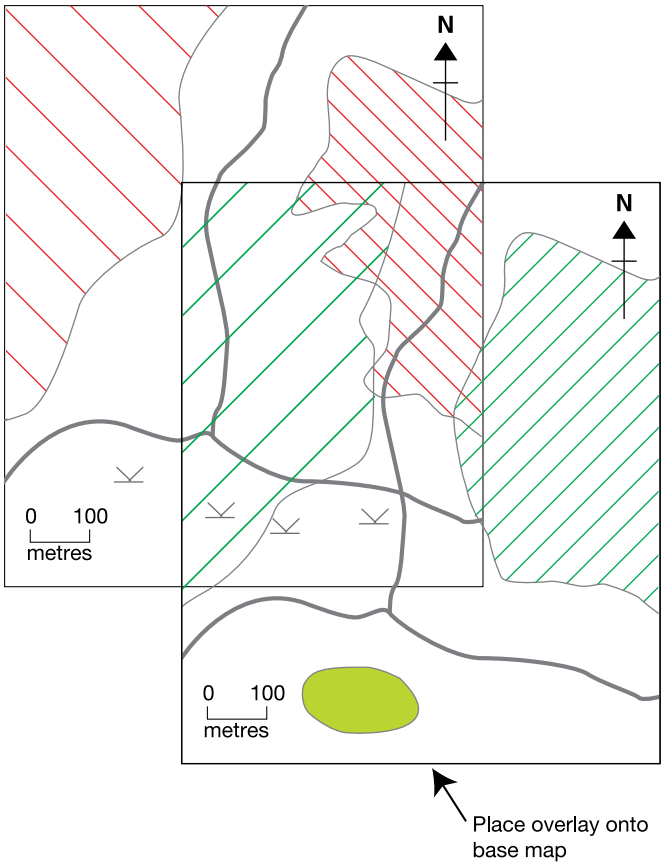
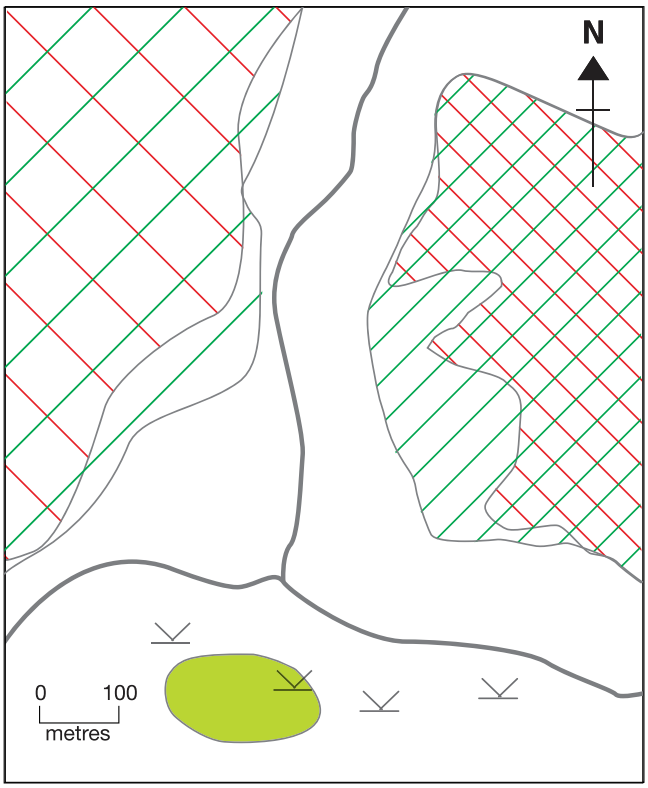


FIGURE 5 This overlay map reveals that farmland tends to be found in areas with fertile soils, and that forest tends to be found in hilly areas.



eBook*plus*

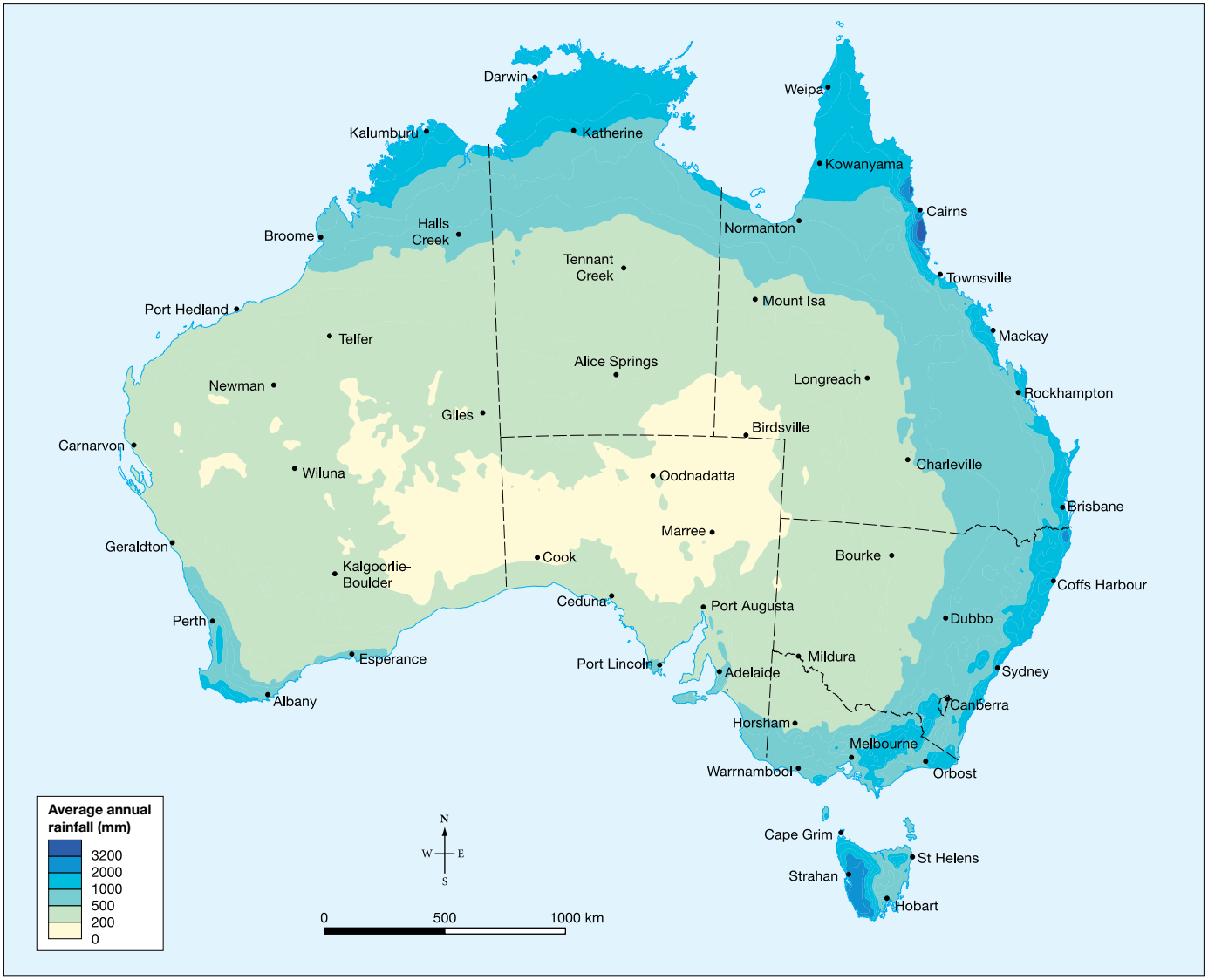
Interactivity
Creating and analysing overlay maps
Searchlight ID: int-3141

10.12.3 Let me do it

Developing my skills

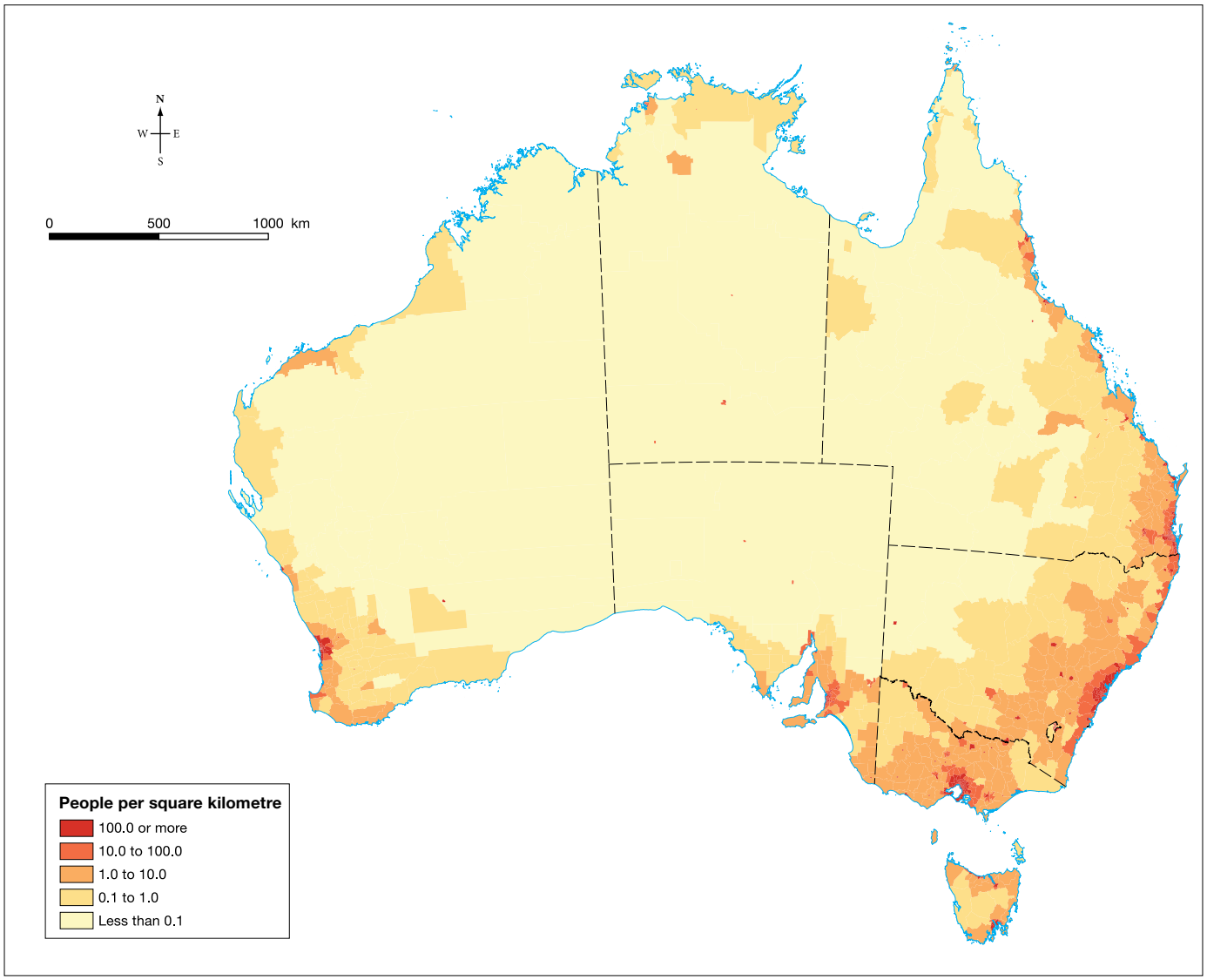
Create an overlay map to show the relationship between Australia's rainfall (figure 6) and population distribution (figure 7). Construct a base map of rainfall patterns.

FIGURE 6 Base map, Australian rainfall



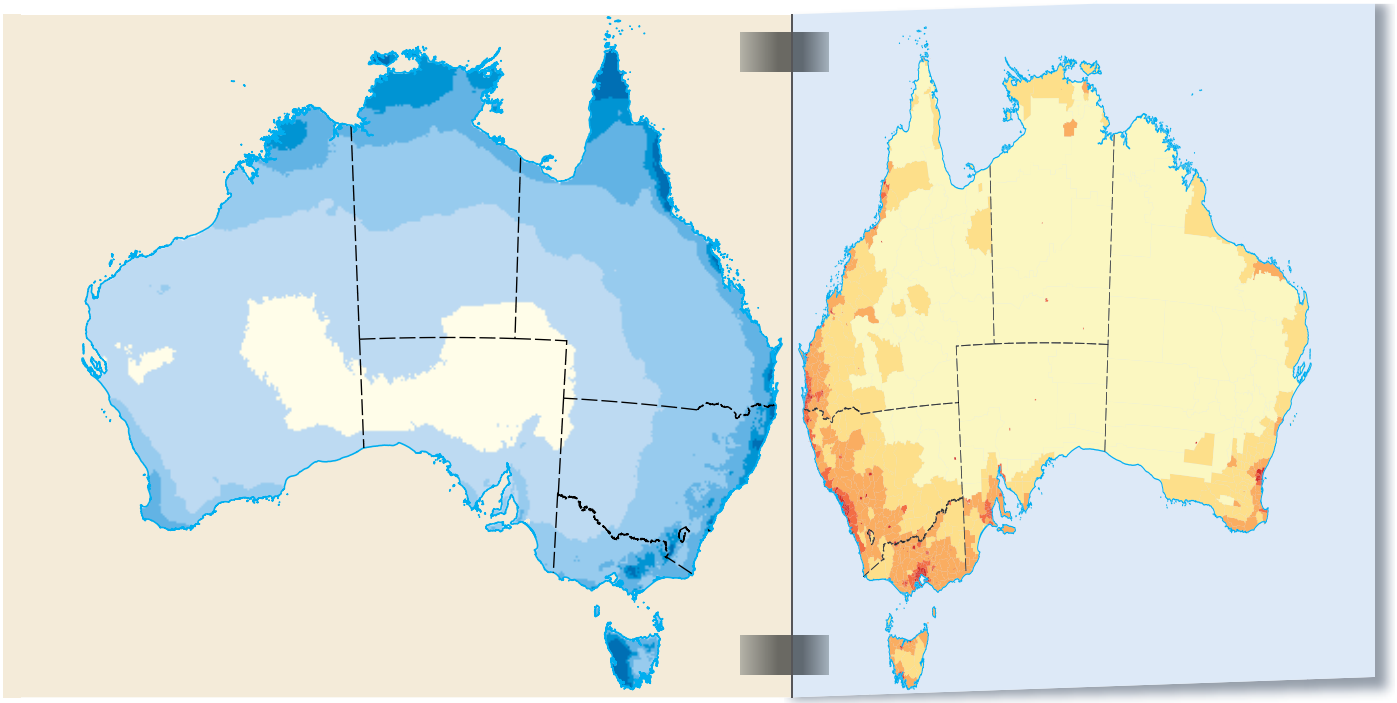
Source: Bureau of Meteorology

FIGURE 7 Overlay map, Australian population density



Source: Australian Bureau of Statistics

FIGURE 8 Base map with overlay



Questions

1. Look carefully at your overlay map and hunt for patterns between them. Find examples where rainfall and population:
   a. mostly coincide with each other
   b. sometimes coincide with each other
   c. do not coincide at all with each other.
2. Describe these areas, either by percentage or by amount of overlap.
3. How strong is the spatial association (relationship) between:
   a. high rainfall and high population density
   b. low rainfall and a low population density?

Checklist

I have:

- drawn in pencil first and then added colour
- included BOLTSS on the base map
- used light colours on the overlay
- included a key on the overlay
- hinged the overlay to the base map using sticky tape
- included a title for the overlay.

Skills questions

1. Overlay maps are most useful for:
   a. comparing two or more different features on a map
   b. investigating air pressure
   c. illustrating statistics
   d. none of the above.
2. Spatial association is:
   a. used to describe the distance between two objects
   b. the location of a single object
   c. the extent to which features are found in a similar distribution pattern
   d. a city in South Africa.
3. Why should you use light colours on a map overlay?
4. Why is it important to include BOLTSS on a base map?

10.14 Review

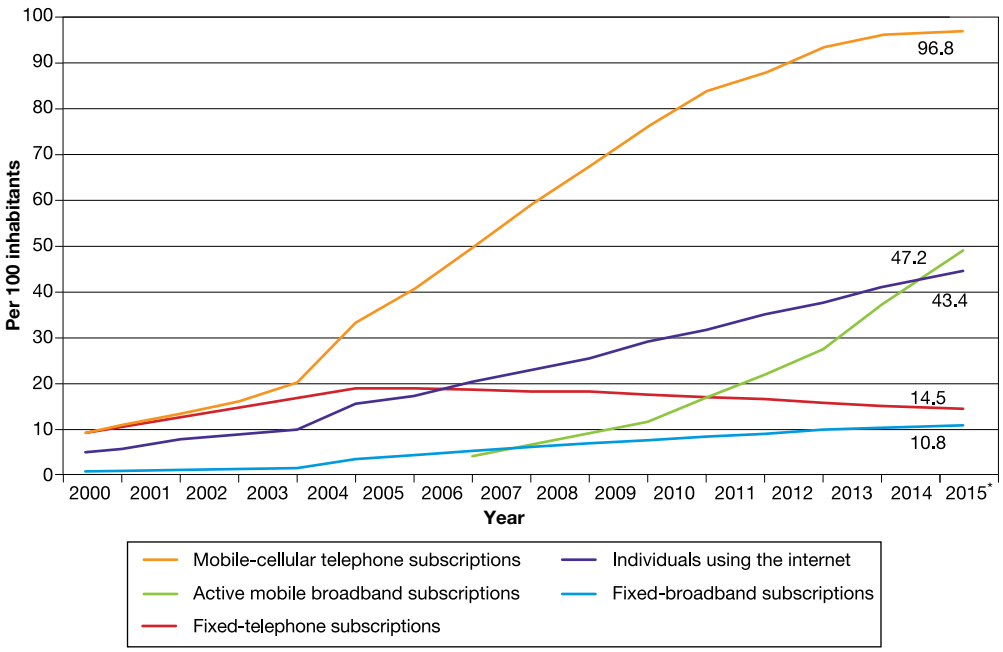
10.14.1 Review

1. Describe five factors that influence liveability.
2. Explain how liveability can ***change*** over time.
3. Why is infrastructure so important for improving liveability?
4. Identify similarities between the housing types in Port Moresby and Dhaka.
5. What sorts of jobs do people from the poorer regions of Port Moresby and Dhaka have access to?
6. Explain how liveability can be improved.
7. How many Sustainable Development Goals are there?
8. Explain why NGOs are important.
9. In the area in which you live, what is an example of a liveability improvement that has been provided by local government or a local group?

10.14.2 Reflect

10. How does the ***place*** in which you live influence your view of what makes a satisfactory standard of liveability?
11. How can liveability be improved in Port Moresby?
12. Study the line graphs that show global information and communication technology (ICT) developments between 2001 and 2015 (figure 1).
    a. Describe the changes in mobile cellular telephone subscriptions between 2001 and 2015.
    b. Suggest reasons why the number of fixed telephone subscriptions declined between 2001 and 2015.
    c. Account for the slow growth in fixed (wired) broadband subscriptions.
    d. With reference to the graph, explain how ICT improves liveability.

FIGURE 1 Global ICT developments, 2001–15



Source: International Telecommunications Union

CHAPTER 11

Geographical inquiry: What is my place like?

11.1 Overview

11.1.1 Scenario and task

Task: Create a blog that presents demographic characteristics of your local place.

Every person has their own idea of what their local place is like. For some people, this area can be very large; for others, it can be quite small. It really depends on where you go in your everyday life. For example, homes of relatives or friends, sports clubs, shops and parks. This means that it does not matter if your map representing your place is a different size or shape to those of friends who live in the same area. The differences simply reflect what you do and think as an individual person.

When you draw a mental map of your local place, you identify the features that you think give your neighbourhood a sense of place. All local areas have these special features that create the character or personality of the place. Many of these features can be identified on maps of the area. But there are also characteristics of your local area that you may not know about. How do you find out about these?

The Australian Bureau of Statistics (ABS) is the Commonwealth Government's organisation that has the responsibility to collect, collate and report information about Australia's people. Every five years, the ABS conducts a major survey of all Australians, as they are living on one specified day of the year. This is called the census. The ABS then compiles this information and releases it for publication, which is when it is used by governments, businesses, companies and individuals to plan for the future.



Your task

Create a blog that presents demographic characteristics of your local place. The Australian Bureau of Statistics (ABS) website (www.abs.gov.au) provides a pathway for you to find out the demographic characteristics of your chosen postcode area.

11.2 Inquiry process

11.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You will write your blog entries individually, but you could work in groups of three to share your research in the ProjectsPLUS Research Forum and create your blog. Save your settings and the project will be launched.

- **Planning:** You will need to research the demographic characteristics of your chosen local place. Locate and print a map of your chosen place to accompany the data you find. Navigate to your Research Forum. Use the research topics to select the characteristics you are interested in exploring for your place. Note that if you would like to focus on a particular issue that is not on the list, obtain permission from your teacher before starting the task.



11.2.2 Collecting and recording data

For this inquiry, go to the Australian Bureau of Statistics (ABS) website (www.abs.gov.au) and select the 'Census' page. Click on 'Data & analysis' in the menu at left and choose 'QuickStats'. Under 'QuickStats Search', select the most recent census year, type your postcode or place name into the search box and select 'Go'. This will bring a map of your local area and related data onto the screen. Choose either People, Families or Dwellings to gather information about.

- **Going further**
  - Compare the changes to your place over time. Choose the same topic for different census years and compare the data.
  - Compare your local area with another local place in your region or city. The other place could be next to yours or a long distance away.

11.2.3 Processing and analysing your information and data

Having collected the information about your local place, you now need to study the data and describe the patterns you have found.

1. How does your place compare with the neighbouring places?
2. What do the combinations of characteristics you have chosen tell you about the community in your postcode?
3. What do the charts tell you that you did not know about the different places in the region where you live?
4. If you have looked at change over time, compare the two charts and describe how the distribution of that characteristic changed over the years. Suggest reasons to explain these changes.

Visit your Media Centre and download the blog planning template to help you develop your blog. You will also see a sample blog on which you can model your own task. Your Media Centre also includes images, videos and audio files to help bring your blog to life.

11.2.4 Communicating your findings

Use an online blogging site to set up your group's blog and then enter all of the required blog entries. Be sure to create a headline for your article and add relevant tables, graphs, images and videos. Your article should emphasise the important facts, and how and why they have changed over time.

11.3 Review

11.3.1 Reflecting on your work

Think back over how well you worked with your group on the various tasks for this inquiry. Determine strengths and weaknesses and recommend changes if you were to repeat the exercise. Identify one area where you were pleased with your performance, and an area where you would like to improve. Write two sentences outlining how you might be able to do this.

Print out your Research Report from ProjectsPLUS and hand it in with your blog and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

Suggested software

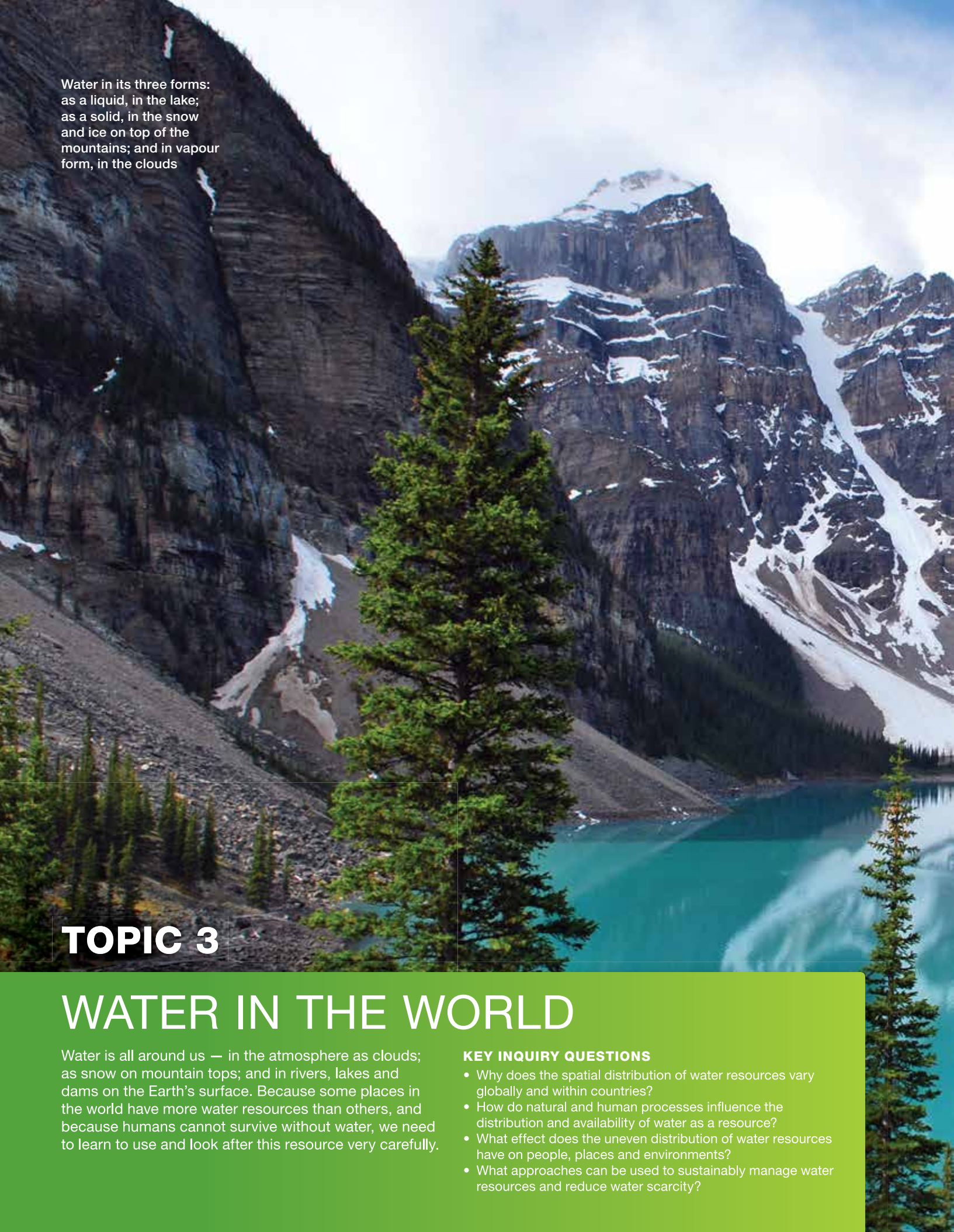
- ProjectsPLUS
- Microsoft Word
- Online blogging site

Media Centre

Your Media Centre contains:

- a blog model
- a feature article scaffold
- a selection of images and audio and video files to add richness to your blog
- weblinks to research sites and blogging websites
- an assessment rubric.





Water in its three forms: as a liquid, in the lake; as a solid, in the snow and ice on top of the mountains; and in vapour form, in the clouds

TOPIC 3

WATER IN THE WORLD

Water is all around us — in the atmosphere as clouds; as snow on mountain tops; and in rivers, lakes and dams on the Earth's surface. Because some places in the world have more water resources than others, and because humans cannot survive without water, we need to learn to use and look after this resource very carefully.

KEY INQUIRY QUESTIONS

- Why does the spatial distribution of water resources vary globally and within countries?
- How do natural and human processes influence the distribution and availability of water as a resource?
- What effect does the uneven distribution of water resources have on people, places and environments?
- What approaches can be used to sustainably manage water resources and reduce water scarcity?





This picture shows what all of Earth's water would look like if it were contained in a sphere, in comparison with the size of the Earth. The blue sphere representing all of Earth's water has a diameter of 1385 kilometres.

CHAPTER 12

Water in the world

12.1 Overview

12.1.1 Introduction

Viewed from space, the Earth is a sphere of blue. Water covers most of our planet. We depend on water for life; in fact, no life is possible without it. Water is a precious and finite resource, yet most of the Earth's water is too salty for humans, animals or plants to use. A number of factors affect where water is available around the globe and as a result, water is not distributed equally around the planet. Weather is one factor that influences the level of precipitation experienced in different places.

Starter questions

1. Describe how the weather affects your everyday life.
2. List some natural resources that are used by your family on a daily basis.
3. List two natural ***environments*** that have a lot of water. Name where they are or show their location on a map.
4. Why do you think water is thought of as a precious resource? Justify your answer.

Inquiry sequence

		Syllabus outcomes
12.1 Overview		
12.2 What is a resource?		GE4-1, GE4-2, GE4-8
12.3 Is water a renewable resource?		GE4-1, GE4-2, GE4-8
12.4 SkillBuilder: Interpreting diagrams	eBookplus ONLINE ONLY	GE4-7, GE4-8
12.5 How much water is there in the world?	eBookplus ONLINE ONLY	GE4-1, GE4-2, GE4-8
12.6 How is groundwater used as a resource?		GE4-1, GE4-2, GE4-3, GE4-8
12.7 How does water flow through catchments?		GE4-1, GE4-2, GE4-3, GE4-8
12.8 What factors affect water availability?		GE4-2, GE4-3, GE4-7, GE4-8
12.9 What is the difference between weather and climate?		GE4-2, GE4-3, GE4-7, GE4-8
12.10 SkillBuilder: Reading a synoptic chart	eBookplus ONLINE ONLY	GE4-7, GE4-8
12.11 Investigating topographic maps: How does water flow down the Haast River?		GE4-2, GE4-3, GE4-7, GE4-8
12.12 Why does the wind blow?	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-7, GE4-8
12.13 How strong is the wind?	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-7, GE4-8
12.14 Review	eBookplus ONLINE ONLY	GE4-1, GE4-2, GE4-3, GE4-7, GE4-8
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
A world of water
Searchlight ID: eles-1616



12.2 What is a resource?

12.2.1 Global supply

We depend on natural resources to survive. We need water to drink, soil to produce our food, and forests and mines to supply other materials. Natural resources are raw materials that occur in the environment and which are necessary or useful to people. They include soil, water, mineral deposits, fossil fuels, plants and animals.

There are two types of natural resources: non-renewable and renewable.

Renewable resources are those that can be replaced in a short time. For example, solar energy is a renewable resource that can be used for heating water or generating electricity. It is never used up and is constantly being replaced by the sun.

fossil fuels fuels that come from the breakdown of living materials, and which are formed in the ground over millions of years. Examples include coal, oil and natural gas.

Non-renewable resources are those that cannot be replaced in a short time. For example, **fossil fuels** such as oil, coal and natural gas are non-renewable because they take thousands of years to be replaced.

We cannot make more non-renewable resources; they are limited and will eventually run out. However, renewable natural resources are things that can grow or be replaced over time if they are carefully managed. Forests, soils and fresh water are renewable.

FIGURE 1 Many resources are required to provide a family with breakfast.



Some renewable resources will always be available for use regardless of human activity, such as energy from the sun or tides. However, human activities can impact on our ability to use some renewable resources such as water or soils. We can have a negative impact on the quality of these resources or their ability to regenerate. For example, chemical dumping could make water undrinkable or overfishing could reduce the ability of a fish species to reproduce at a rate to sustain the population.

uranium radioactive metal used as a fuel in nuclear reactors

The global distribution of natural resources depends on geology (the materials and rocks that make up the Earth) and climate. Some minerals are rare and are found in only a few locations. For example, **uranium** is found mainly in Australia. Several countries in the Middle East, such as Saudi Arabia and Iran, have rich oil resources but are short of water. Many countries in Africa, such as Botswana, have mineral resources but lack the money to mine and process them.

subsistence farming a form of agriculture that provides food for the needs of only the farmer's family, leaving little or none to sell

The human activities of agriculture, fishing, logging and mining all depend directly on natural resources. In developing countries, traditional forms of agriculture such as **subsistence farming** and nomadic herding are still common. These activities are sustainable if farmers move on when an area

becomes unproductive, allowing the land to recover. However, poverty and population growth mean that many people now clear forests for farms and overgraze or overcrop small plots of land, resulting in deforestation and land degradation.

FIGURE 2 Natural resources — renewable and non-renewable

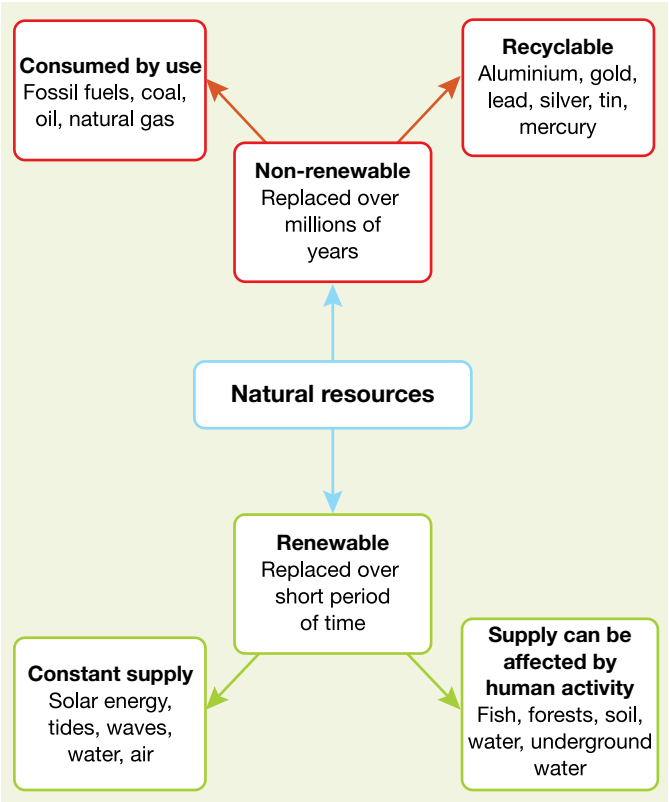
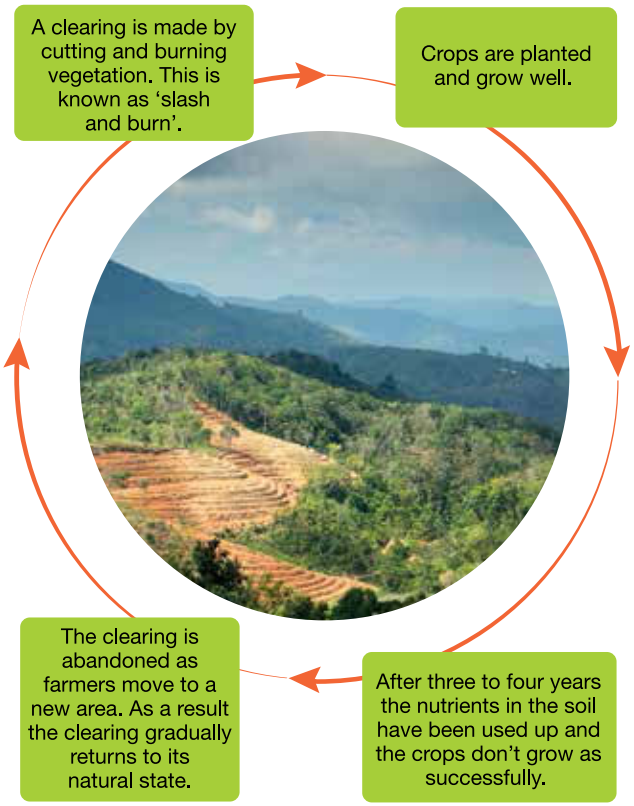


FIGURE 3 The process of shifting cultivation



Farms in developed countries are usually much larger. For example, the Anna Creek cattle station in South Australia is 24 000 square kilometres, the size of Belgium. In contrast, an average intensive rice farm in Bali is only about one hectare. This is about four times the size of an Australian quarter-acre block of land. Unsustainable agricultural practices in developed countries include the overuse of water, fertilisers and pesticides. For example, fertilisers help crops to grow, but when they end up in rivers and oceans as run-off, they cause algal blooms and damage coral reefs.

ACTIVITIES

IDENTIFY

1 What is a natural resource?
2 Outline the difference between renewable and non-renewable resources.
3 List three examples of non-renewable resources that can be recycled.

EXPLAIN

4 Which renewable resources are most affected by human activity? Why?
5 When it comes to using natural resources, there are two main problems people face. What are they and why are they important?
6 What does *the sustainable use of natural resources* mean?
7 Why is shifting cultivation a ***sustainable*** form of agriculture?

APPLY

8 Refer to figure 3. Use the internet to research who uses shifting cultivation around the world. Choose one case study and report back to the class about their way of life. Examples of these may include tribes from the Amazon, Congo Basin or Papua New Guinea. Compare your chosen tribe's way of life with your way of life, and explain how it differs when it comes to using resources and accessing food. Upon completion of the presentations, discuss as a class why you think Australian farmers do not use shifting cultivation as their method of agricultural production.
9 What did you have for breakfast today? What resources would have been required to provide it?
10 What are examples of fossil fuels that you use in order to maintain your lifestyle?
11 Create a table that lists 10 renewable and 10 non-renewable resources used by your family. Be specific; for example, list timber used in your furniture. From your list, note some of the waste and pollution that may be created in the use or creation of these resources. How could this be reduced to improve ***environmental sustainability***?

12.3 Is water a renewable resource?

12.3.1 Water as a resource

A renewable resource is one that can replenish or replace itself in a relatively short period of time. Water is an example of a renewable resource.

eBook*plus*

Interactivity
Water works
Use this interactivity to learn how the water cycle works.
Searchlight ID: int-3077

The amount of water on Earth has not changed since the beginning of time; there is only a finite, or fixed, amount. The water used by ancient and extinct animals and plants millions of years ago is the same water that today falls as rain. The amount of water cannot be increased or decreased. It is cycled and recycled, and constantly changes its state from gas, to liquid, to solid, and back.

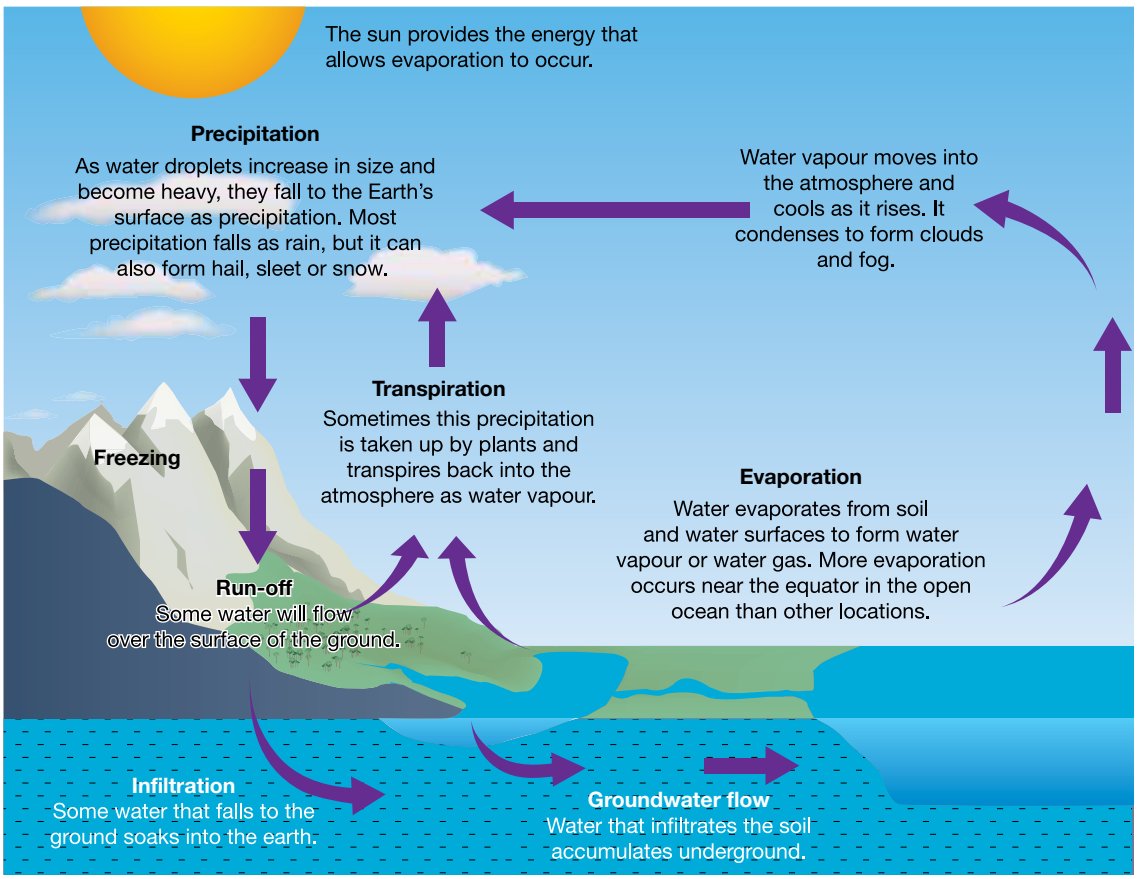
Despite there being a finite amount of water on Earth, it is viewed as renewable because it is in a constantly changing state from gas, to liquid, to solid and back. If water is managed properly it can be renewed or recycled and then reused continuously.

The water cycle

All the water on Earth moves through a cycle that is powered by the sun. This cycle is called the water cycle, or **hydrologic cycle**. Water is constantly changing its location (through constant movement) and its form (from gas, to liquid, to solid). Evaporation, condensation and freezing of water occur during the cycle.

hydrologic cycle another term for the water cycle

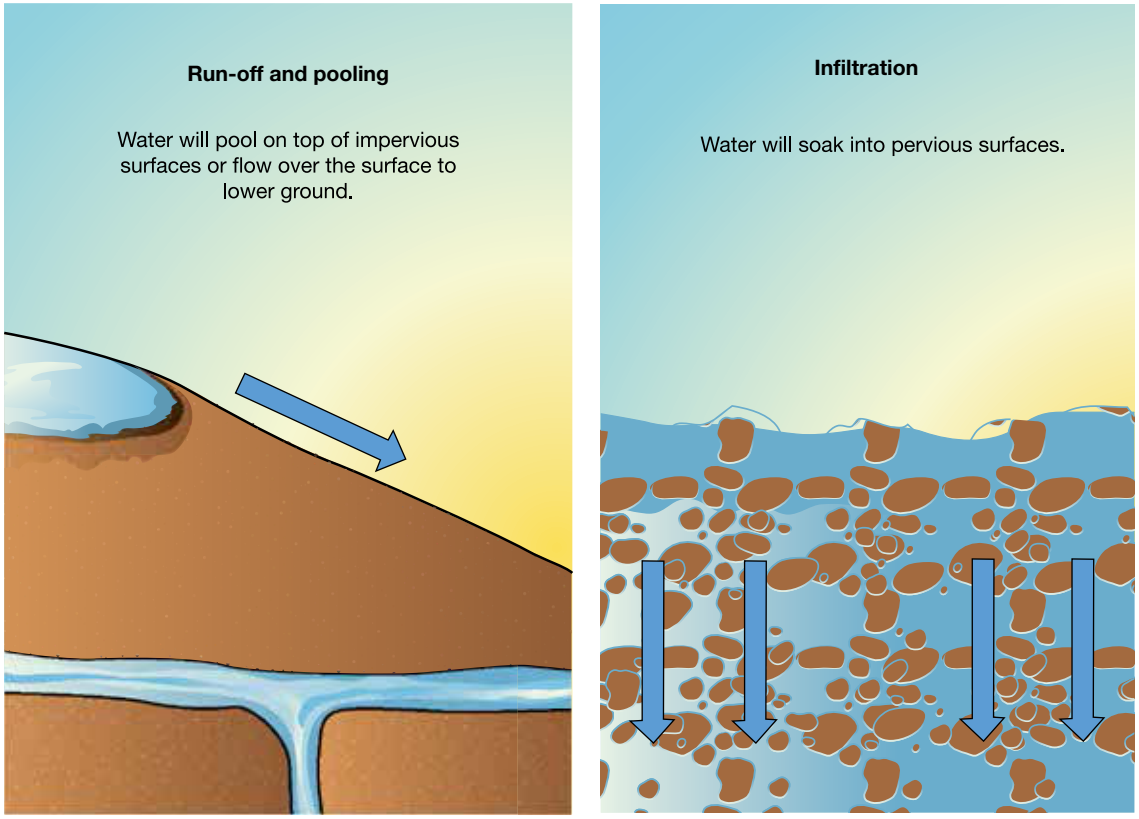
FIGURE 1 The water cycle



Key processes in the water cycle are precipitation, infiltration, run-off, storage, evaporation, evapotranspiration and condensation. In some locations and climates water will also freeze as part of the water cycle. Water is stored in oceans, lakes and rivers. The sun's heat changes water from its liquid form into a gas. This is known as evaporation. When the water vapour rises and cools it condenses, and when it becomes heavy enough it will fall back to earth as precipitation. If the land is very steep

or the soil is very hard, water is likely to run off to lower ground. If the soil is permeable (having small spaces or gaps) the water may infiltrate underground. Water that has infiltrated will become part of groundwater flow beneath the earth's surface. This water will either accumulate in underground storage or slowly make its way to streams and rivers.

FIGURE 2 Run-off and infiltration are processes in the water cycle.



GEOskills TOOLBOX

Interpreting diagrams

Diagrams provide a way to present complex information in a visual form. They can be useful to show processes, relationships or abstract ideas. Examine SkillBuilder 12.4 'Interpreting diagrams' in your eBookPLUS. Examine the diagram of the water cycle in figure 1.

1 Describe the water cycle.
2 List one difference and one similarity between transpiration and condensation.
3 Explain how infiltration, groundwater and run-off are related.

ACTIVITIES

IDENTIFY

1 Is water a renewable or a non-renewable resource?
2 List all the ways that water can be used as a resource.
3 Name two ***places*** where water stays in the same ***place*** for the longest.

EXPLAIN

4 Using the information about the water cycle, write and present 'The incredible journey of water'. Focus on various ***interconnections*** between water and the ***environment***. Include diagrams and photographs, and present your story electronically, as a poster, a written piece, a drama piece or a song.
5 How does the water cycle prove that we are using the same water that the dinosaurs used — in other words, that it is finite (limited)?

PREDICT

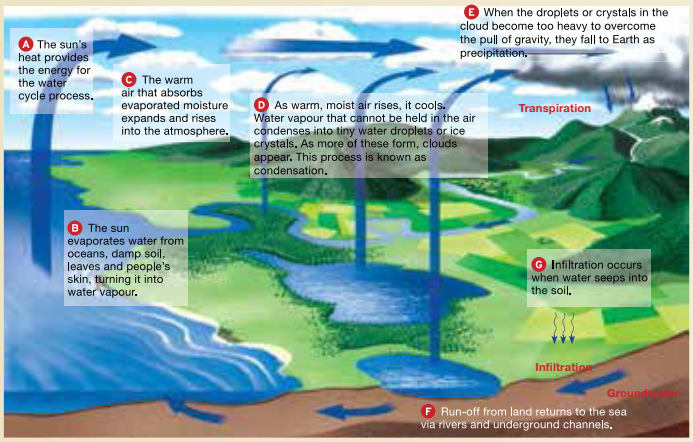
6 With a global population that is increasing by about 78 million people each year, how will it be possible for the finite water on Earth to be shared fairly?

eBookplus ONLINE ONLY

12.4 SkillBuilder: Interpreting diagrams

What are diagrams?

A diagram is a graphic representation of something. In geography, it is often a simple way of showing the arrangement of elements in a landscape and the relationships between those elements. Diagrams also have annotations: labels that explain aspects of the illustration.



eLesson

Watch this video to learn how to interpret a diagram.



Searchlight ID: eles-1636

Interactivity

Try this interactivity to learn how to interpret a diagram.



Searchlight ID: int-3132

eBookplus ONLINE ONLY

12.5 How much water is there in the world?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

12.6 How is groundwater used as a resource?

12.6.1 What is groundwater?

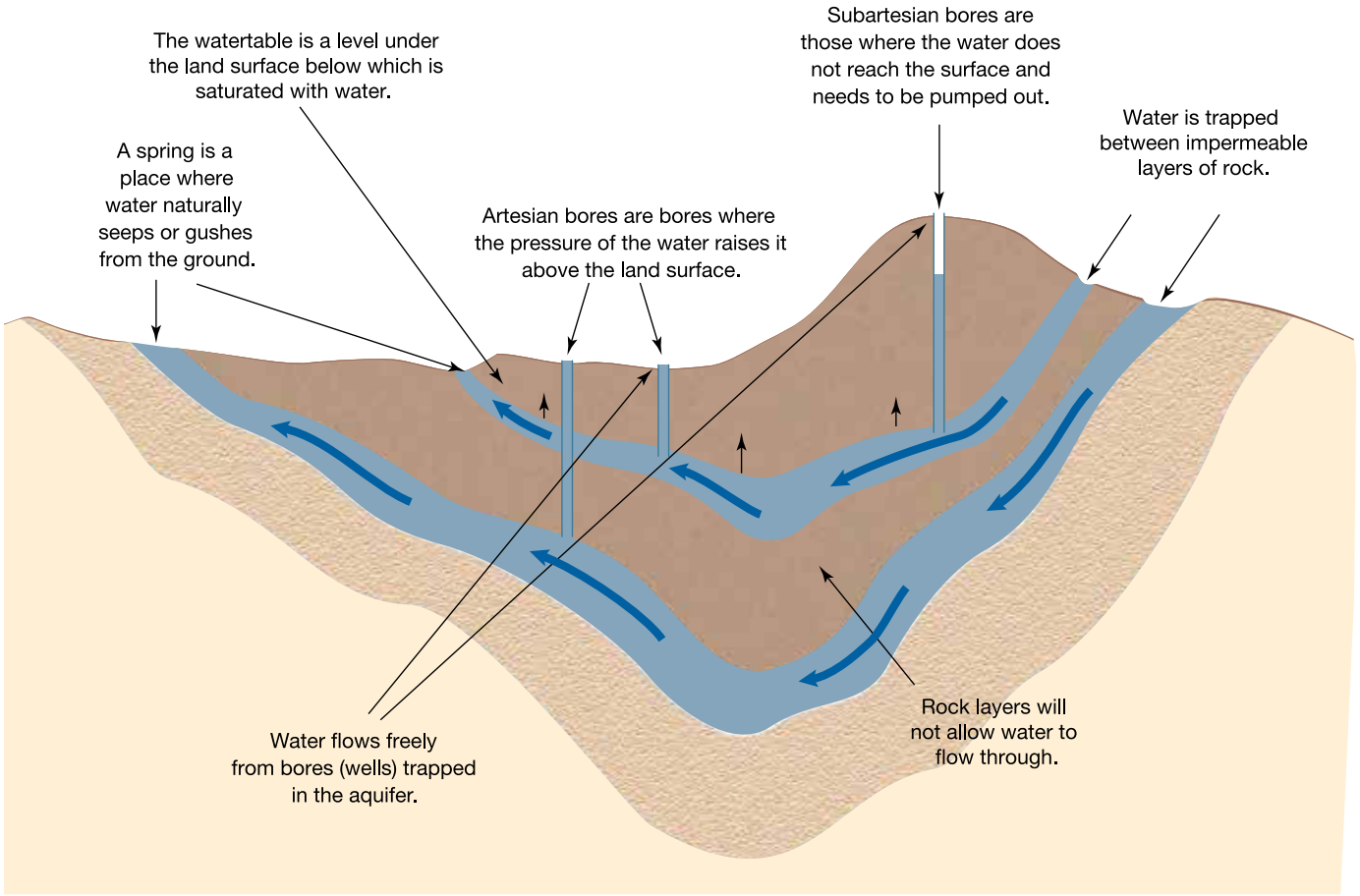
An important part of the water cycle, groundwater is the water that is found under the Earth's surface. Many settlements — especially those in arid and semi-arid areas — rely on groundwater for their water supply.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater. Water can move along an aquifer.

When rain falls to the ground, some flows over the surface into waterways and some seeps into the ground. Any seeping water moves down through soil and rocks that are permeable; that is, they have pores that allow water to pass through them. Imagine pouring water into a jar of sand or pebbles; the water would settle into the spaces between the sand or stones.

Groundwater is water held within water-bearing rocks, or **aquifers**, in the ground. These work like sponges. They hold water in the tiny holes between the rock particles.

FIGURE 1 An artesian aquifer



An **artesian aquifer** occurs between impermeable rocks, and this creates great pressure. When a well is bored into an artesian aquifer, water often gushes out onto the surface. This flow will not stop unless the water pressure is reduced or the bore is capped (sealed).

Groundwater and surface water are interconnected — they depend on each other. Groundwater is only replenished when surface water seeps into aquifers. This is called **groundwater recharge**, and it is affected by whether there is a lot of rain or a drought is occurring.

artesian aquifer an aquifer confined between impermeable layers of rock. The water in it is under pressure and will flow upward through a well or bore.

groundwater recharge a process in which water moves down from the Earth's surface into the groundwater

Global groundwater resources

Approximately two per cent of the Earth's water occurs as groundwater, compared with 0.1 per cent as rivers and lakes and 94 per cent as oceans.

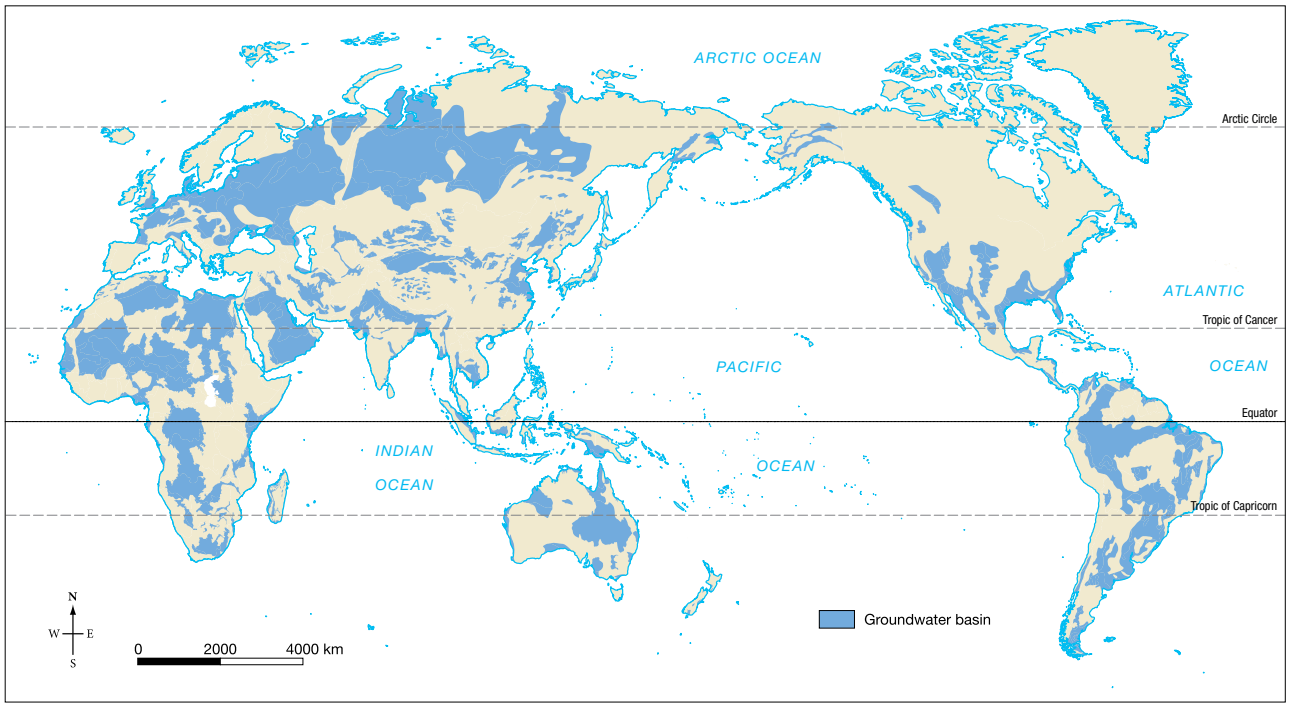
About 1.5 billion people in the world rely on groundwater for their survival. Some groundwater is fresh and can be used for drinking. Other groundwater can be brackish or even saltier than the sea.

Groundwater is vital for drinking, irrigation and industry use. Some industries bottle and sell spring and mineral water, and make soft drinks and beer. Bore water is used to water suburban gardens and parks, golf courses and crops. Groundwater is also important to the natural environment in wetlands and in supporting unique plants and animals. Groundwater keeps many of our rivers flowing, even when there are long periods without rain.

FIGURE 2 The water in this mound spring in South Australia has taken over two million years to move to the surface from recharge areas in northern Queensland. It can take up to 1000 years to move about one metre.



FIGURE 3 The world's major groundwater basins



Source: Spatial Vision

Troubled waters

For many years now, more and more water has been taken out of the ground. People believed it was unlimited, but it is in danger of running out in some areas, owing to the large number of wells pumping water.

If people use more groundwater than is being recharged, aquifers may dry up. Groundwater is very slow-moving and can take many years to move into deep aquifers. For this reason, groundwater is a finite and non-renewable resource, and is often referred to as *fossil water*.

eBook*plus*

Interactivity
Water beneath us
Use this interactivity to check your knowledge of groundwater.
Searchlight ID: int-3078
Weblink
Bubbl.us

ACTIVITIES

IDENTIFY

1 What does the word *permeable* mean?
2 What is groundwater recharge?

EXPLAIN

3 What is the difference between an aquifer and an artesian aquifer? Use a diagram to help you.
4 Draw a diagram to show how surface water reaches the watertable to become groundwater.
5 Describe conditions that might result in a watertable rising or falling.
6 Outline how groundwater and surface water are ***interconnected***.
7 Describe the groundwater resources in North Africa and West Asia (the Middle East). (Refer to the 'Regions' resource in your eBookPLUS.)

APPLY

8 Refer to figure 3 to describe the location of the world's groundwater regions.

PREDICT

9 Imagine that the world's groundwater continues to be used faster than it can be replaced. Use the **Bubbl.us** weblink in your eBookPLUS to brainstorm all the possible consequences this will have on people and the ***environment***.

INVESTIGATE

10 Water is a renewable resource. Why is groundwater sometimes thought of as fossil water and as a non-renewable resource? Write your answer as a newspaper article titled 'Out of sight, out of mind'.

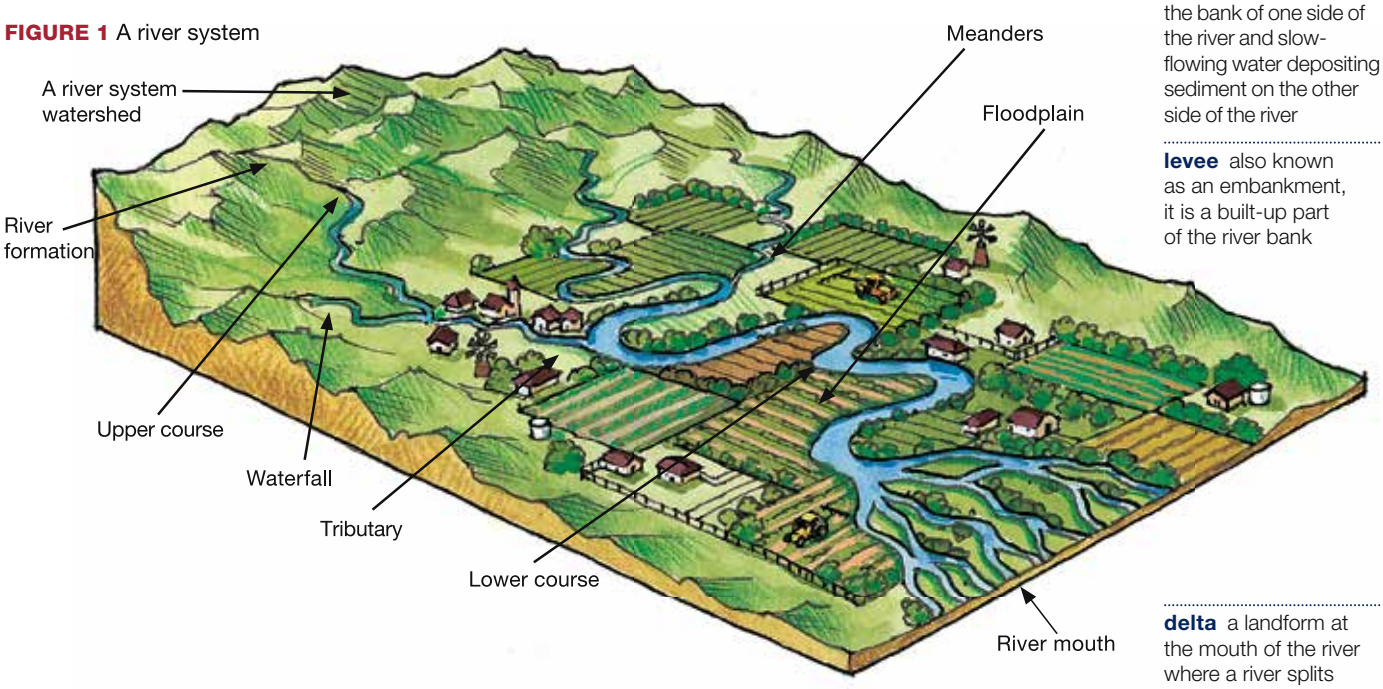
myWorldAtlas Deepen your understanding of this topic with related case studies and questions
› Salisbury Council — Aquifer storage, transfer and recovery

12.7 How does water flow through catchments?

12.7.1 The upper catchment

A catchment is an area of land surrounded by hills or mountains where water collects. The mountains that surround the area separate it from adjoining catchments. These boundary mountains are called watersheds.

FIGURE 1 A river system



floodplain the area of land next to the river, usually reaching to the base of the mountains surrounding the catchment. It experiences flooding during peak rainfall periods.

meander a curve in a river caused by fast-flowing water eroding the bank of one side of the river and slow-flowing water depositing sediment on the other side of the river

levee also known as an embankment, it is a built-up part of the river bank

delta a landform at the mouth of the river where a river splits into smaller streams and sediment is deposited to create an arch of land reaching out into the sea

Water in the catchment begins in the headwaters. These are steep-sided channels found in the most elevated parts of the catchment. The headwaters often contain fast-flowing water following periods of rainfall. This fast-flowing water will often carry sediments from the upper part of the catchment into lower areas.

12.7.2 The mid reaches of the catchment

The water flows from the upper part of the catchment into the **floodplain** in the mid reaches of the catchment. The water begins to slow down. As the water slows it will deposit sediment from the upper catchment. This begins to create landform features such as **meander**s, ox-bows and **levees**.

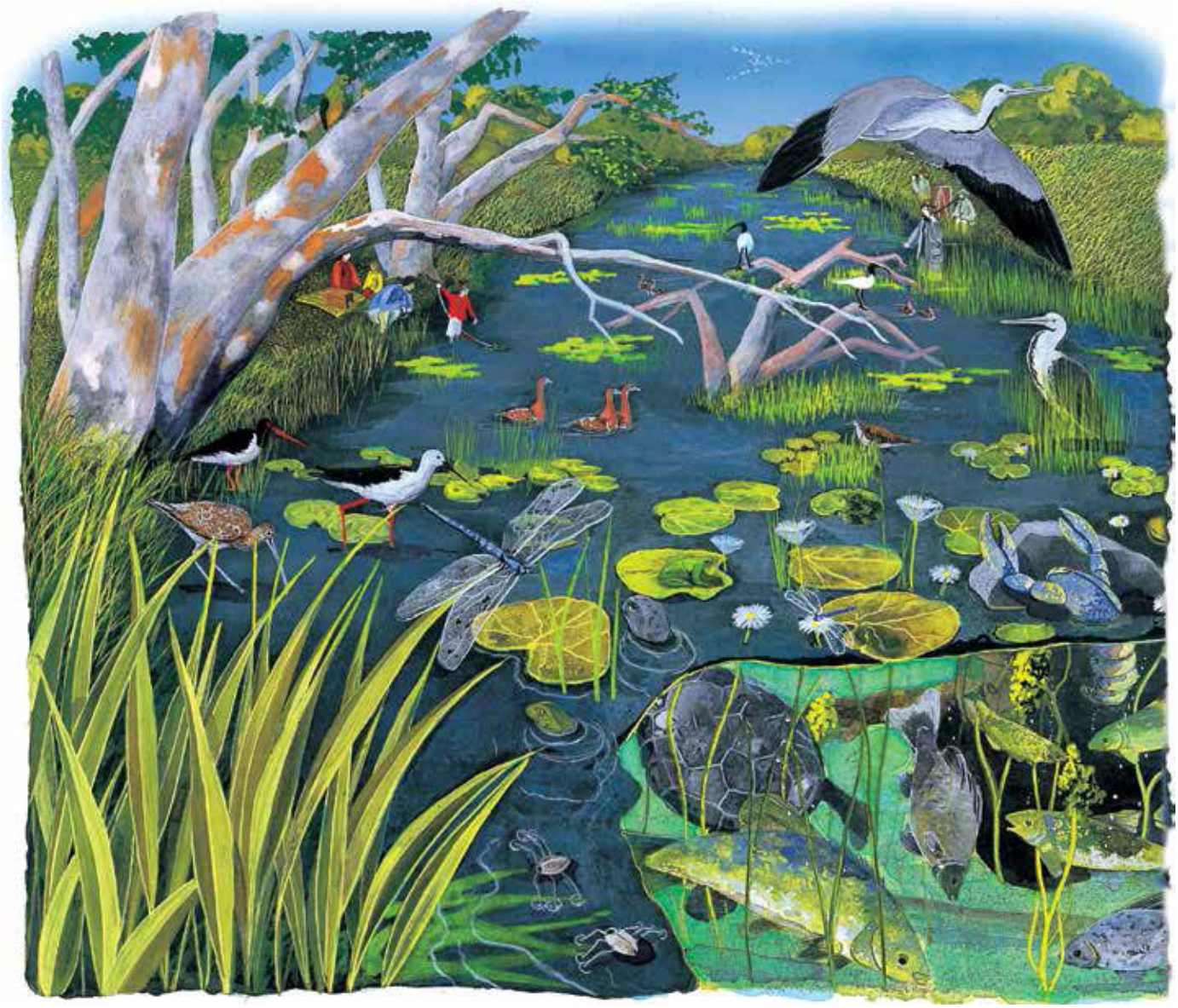
12.7.3 The lower catchment

All rainwater that enters the catchment makes its way to the lowest part of the catchment, eventually flowing down into rivers, lakes, creeks or the sea. Where a river meets the sea the water often slows down again and deposits more sediment. This creates a **delta** where the river breaks into smaller streams.

FIGURE 2 The watershed catchment or drainage basin of a river system



FIGURE 3 This artwork depicts a wetland habitat and some of the wildlife it supports.



FOCUS ON FIELDWORK

Visit a local creek or pond

Observation
Observe the area surrounding the creek or pond. Make some basic notes about the area.

Consider: Are the banks steep or gentle? Is there a lot of vegetation surrounding the area? Does the water look clean or is there evidence of pollution? What human impacts can you observe?

Observe aspects such as colour, odour, and the presence of algae, surface film or oil slicks. Ratings from 1 (excellent) to 5 (extremely poor) can be used and recorded.

Sketch map
Draw a sketch map of the area. Annotate your sketch map with important features or land uses surrounding the study area.

Field sketch
Create a field sketch of the area. To draw your field sketch choose an appropriate scale and then divide your page into foreground, middle ground and background. Draw the skyline in your sketch first and then draw lines showing the main features. Lastly draw in more detailed information such as vegetation, pathways, fences, etc. Field sketches are an important tool to help you interpret photographs or remember details of an environment when you are no longer able to see it.

Measuring river width
Stretch a tape measure 20 centimetres above the water from one bank to the other, measuring from where the dry bank meets the water. Take your reading directly above the tape at several locations and calculate an average.

Measuring the water depth
While the tape measure is stretched across the river or creek, use a metre ruler to measure the depth. Record the depth every 50 centimetres (or 30 centimetres if the creek is small). Make sure the ruler only just touches the riverbed, and record each measurement as it is taken.

Collecting and recording data: animal species
Biodiversity in water is studied by taking a small area of water and investigating the number and diversity of animal species. It is measured by ponding or water sampling. Choose a number of sites in the water and ensure that they contrast with each other: there should be clear, muddy, deep, shallow, moving and still sites, for example. The materials needed for ponding include a fine net; a white plastic ice-cream container; a magnifying glass; a notebook and pencil for recording the number and variety of species; a camera for photographing specimens; and an identification chart or book.

Using a net, scoop the water and examine any aquatic organisms that you find. Refer to an identification chart for aquatic organisms and record the information. You may also like to collect photographic evidence of each scoop.

Collecting and recording data: vegetation
Examine plants found in and around the river or pond. Collect photographic evidence of each species. Use a vegetation chart to identify the plants and record the information.

1 Create a document, e-portfolio or multimedia presentation collating your 'Focus on fieldwork' activities.
2 Use Google Earth, or other sources of virtual maps or satellite images, to provide maps and images of your field site at a variety of scales. Describe the location of your field site in relation to New South Wales and the surrounding area. Provide the latitude and longitude of your field site.
3 Find secondary information about your local creek or pond. This could include websites, newspaper articles or pamphlets. Summarise the key points for each item of secondary information.
4 Scan or photograph your field sketch and sketch map and import your photographs from your fieldwork activities. Examine the data you have collected. Write a few sentences explaining each of your fieldwork techniques and findings.
5 Explain how your **primary data** relates to the **secondary data** you have collected. Does your primary data support the secondary data? Are there differences between your primary data and the secondary data?

primary data
information that you have collected where the researcher uses fieldwork techniques

secondary data
information that has been collected by another person. This could include websites, books or pamphlets.

ACTIVITIES

EXPLAIN
1 What is the difference between a watershed and a catchment?
2 Describe how water flows from the upper catchment to the lower catchment.

12.8 What factors affect water availability?

12.8.1 Latitude

Places near the equator tend to be hotter and more humid than places near the poles. As a result, there is generally more precipitation in low latitude areas than those in higher latitude areas.

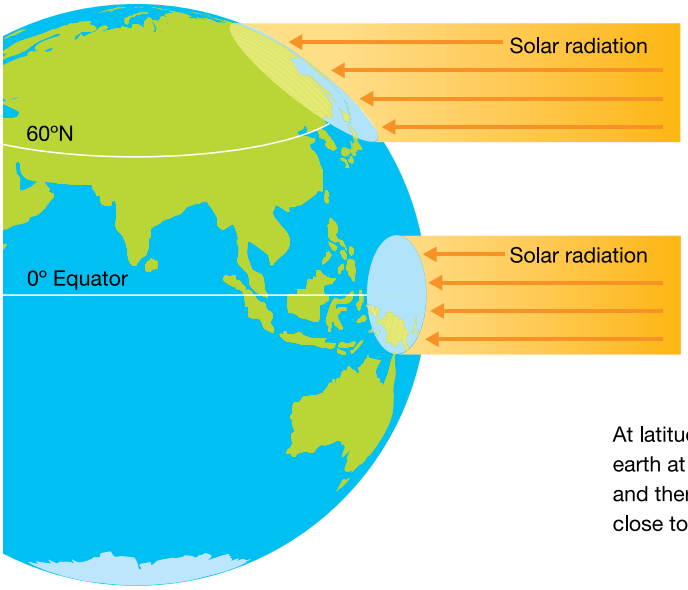
12.8.2 Altitude

As altitude increases rainfall also increases. Condensation occurs as air cools in higher altitudes. The air can no longer hold moisture and precipitation occurs. This precipitation is often in the form of snow.

12.8.3 Ocean currents

Warm ocean currents generally increase the rate of evaporation and result in higher rainfall. Cold ocean currents reduce the amount of evaporation and as a result less rainfall occurs.

FIGURE 1 Temperatures are higher at low latitudes (closer to the equator) because incoming solar radiation has a smaller area of the Earth to heat.



12.8.4 Distance from the sea

Areas close to the sea will receive more rainfall than places further from the sea. This is due to high levels of evaporation over the ocean. As the air mass moves across the land it will drop this moisture.

12.8.5 Geology

Some rocks and soils are more permeable than others. This means they can absorb moisture. Impermeable rocks and soils result in more run-off and higher rates of evaporation. As a result more precipitation occurs.

12.8.6 Topography

As discussed earlier, snow often falls on the top of mountains. However, topography can also affect precipitation on the lower parts of mountains. On the windward side of the slope of the mountain precipitation occurs. On the leeward side of the mountain less precipitation occurs. The leeward side is the side of the mountain that is protected from the wind. This is known as the rainshadow effect.

12.8.7 Climate change

The majority of climate scientists believe that climate change will have an impact on rainfall patterns. Climate models have shown that areas in the northern latitudes are likely to experience more rain, and areas closer to the equator and mid latitudes will receive less rain. Some regions will experience droughts, while others will experience high rainfall and even flooding. Already, in the last 100 years, global rainfall patterns have changed. In some areas such as North America, South America, northern Europe, and northern and central Asia, rainfall has increased significantly. In other areas such as the Sahel, the Mediterranean, southern Africa, and parts of Asia, rainfall has decreased.

FIGURE 2 How rain shadow deserts form

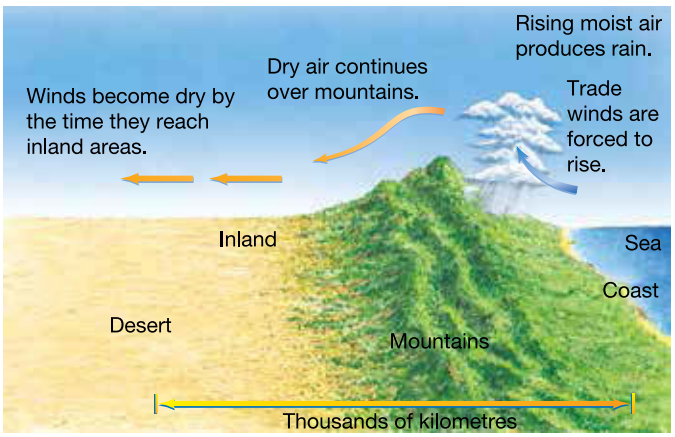
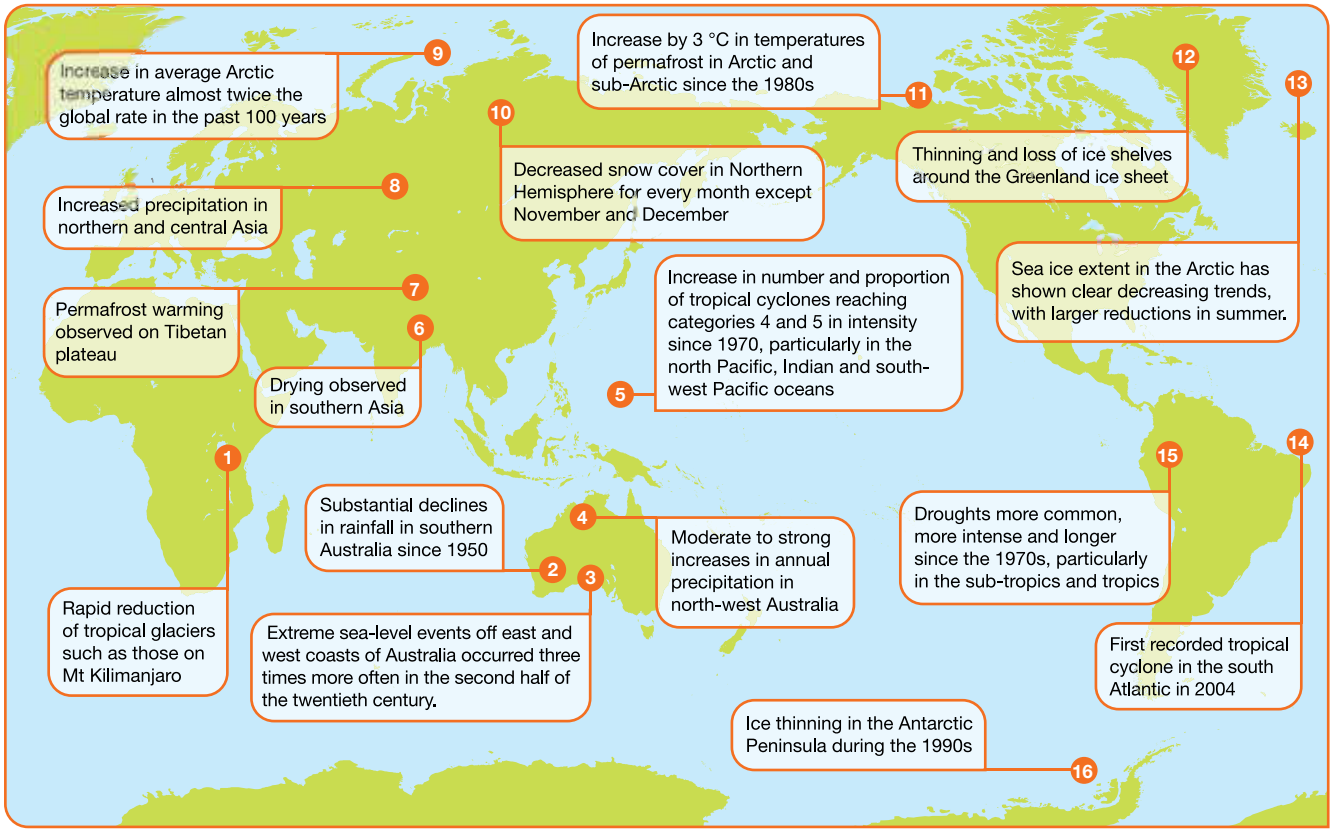


FIGURE 3 Observed evidence of climate change



Source: The Garnaut Climate Change Review, 2008, pages 76–7

FOCUS ON FIELDWORK

Observing clouds

Create a cloud identification chart

To create a cloud identification chart, begin by creating a file and adding the names of different types of clouds. Include cirrocumulus, cirrus, cirrostratus, cumulonimbus, cumulus, stratus, altostratus, altocumulus, nimbostratus and stratocumulus. Find images that show the different types of clouds and paste them into your file. Be sure to include the source of the image. Print your chart to use in the field.

Create a cloud cover sheet

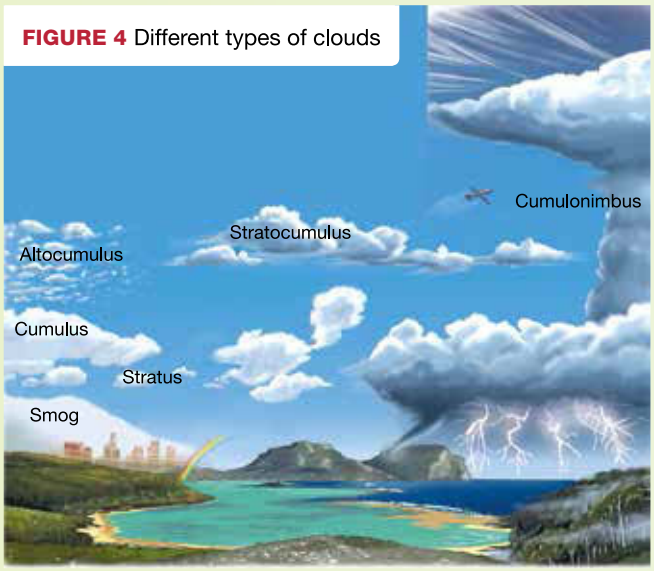
Create a 10 by 10 grid that takes up most of an A4 page and print it onto an overhead sheet.

Observations

Use a compass to find north and face that direction. Use your cloud identification chart to identify the clouds that can be seen looking north. Hold up the cloud cover sheet and count how many squares contain clouds. This will allow you to determine the percentage cloud cover. Repeat this activity facing east, south and west. Compare your answers with your classmates.

1 Identify the different types of clouds.
2 Are some clouds similar to each other? Describe how they are similar.
3 Why might it be useful to know the percentage of cloud cover?

FIGURE 4 Different types of clouds



4 What factors do you think might affect the types and percentage of cloud cover that you observed?

ACTIVITIES

IDENTIFY

1 Describe how topography and altitude can influence precipitation.
2 Create a diagram that demonstrates your understanding of how ocean currents have an impact on rainfall.

EXPLAIN

3 Explain the relationship between the ocean and rainfall. In your answer, use the words 'evaporation', 'distance' and 'currents'.

PREDICT

4 Use the **Bureau of Meteorology** weblink in your eBookPLUS to investigate rainfall patterns in your local area. Using the information you now have about the factors affecting rainfall, how would you explain these rainfall patterns?
5 Work in groups of three to list what might happen to people and the ***environment*** in regions that:
   a will receive more rainfall than they do now
   b will receive less rainfall than they do now.
   Complete a consequence chart for each change.

APPLY

6 Study figure 3 and an atlas.
   a Name three ***places*** that are predicted to receive more run-off due to climate change.
   b Name three ***places*** that are predicted to receive less run-off due to climate change.
   c Compare these six ***places*** with a global rainfall map. Which of the following statements is true? (Rewrite any false ones and make them true.)
   - Most ***places*** with very low rainfall have lower run-off.
   - All ***places*** with very high rainfall experience increased run-off.
   - The ***places*** with the greatest ***change*** in run-off will be northern Russia and northern Canada.

eBookplus

Weblink
Bureau of Meteorology

12.9 What is the difference between weather and climate?

12.9.1 How does weather change?

Our Earth is surrounded by a band of gases called the atmosphere. It protects our planet from the extremes of the sun's heat and the chill of space, making conditions just right for supporting life. The atmosphere has five different layers. The layer that starts at ground level and ends about 16 kilometres above Earth is called the troposphere. Our weather is the result of constant changes to the air in the troposphere. These changes sometimes cause extreme weather events.

Droughts, floods, cyclones, tornadoes, heatwaves and snowfalls — even cloudless days with gentle breezes — all begin with changes to the air in the troposphere. The five main layers in the Earth's atmosphere all differ from one another. For example, the troposphere contains most of the **water vapour** in the atmosphere. As a result, this layer has an important link to **precipitation**.

water vapour water in its gaseous form, formed as a result of evaporation

precipitation the form of water falling from the sky, such as rain, snow or hail

All weather conditions result from different combinations of three factors:

- air temperature
- air movement
- the amount of water in the air.

The sun influences all three.

First, the sun heats the air. It also heats the Earth's surface, which in turn heats the air even more. How hot the Earth's surface becomes depends on the season and the amount of cloud cover.

Second, the sun causes air to move. This is because the sun heats land surfaces more than it heats the oceans. As the warm air over land gets even warmer, it expands and rises. When hot air rises, colder air moves in to take its place.

Third, the sun creates moisture in the air. The heat of the sun causes water on the Earth's surface to **evaporate**, forming water vapour. As this water vapour cools, it condenses, forming clouds. It may return to Earth as rain, dew, fog, snow or hail.

evaporate to change liquid, such as water, into a vapour (gas) through heat

At times these three factors — temperature, air movement and water vapour — can create extreme weather events. Very high air temperatures influence heatwaves; rapidly rising air plays a part in the formation of cyclones; and excess rain can create flooding.

FIGURE 1 Australia experiences a diversity of weather, which has a major effect on how we live.

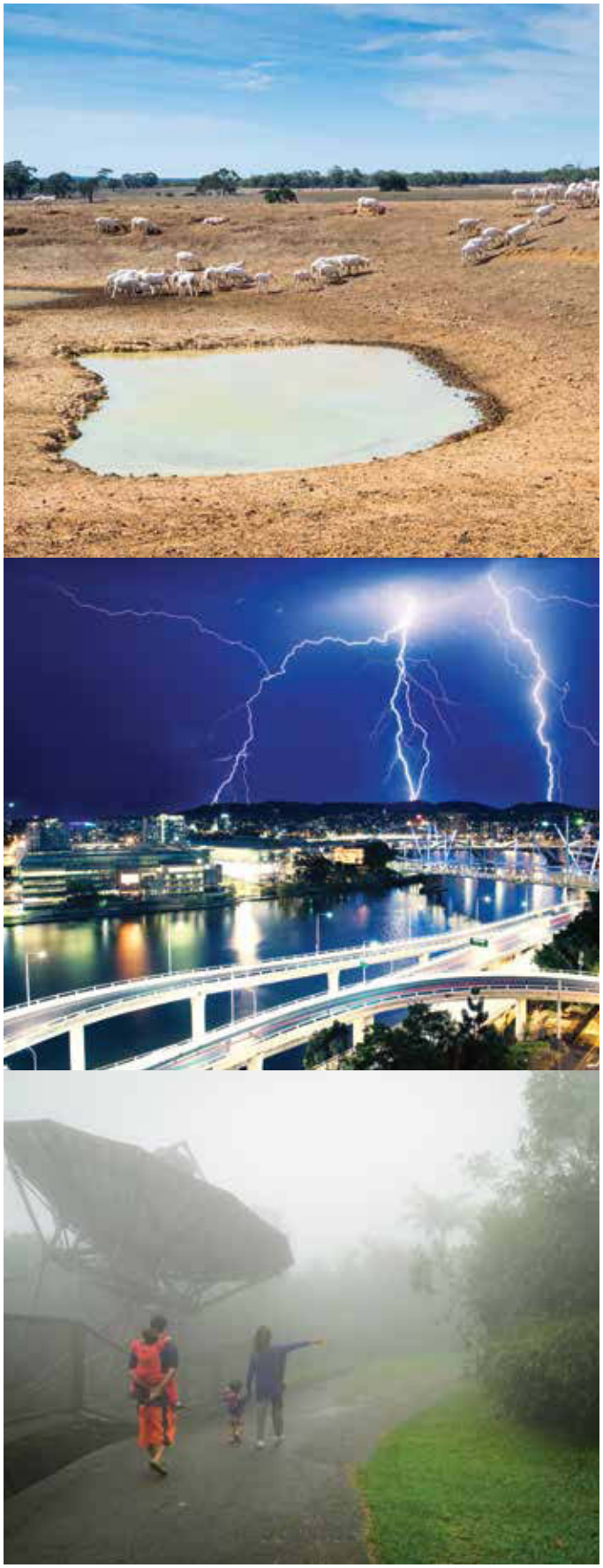
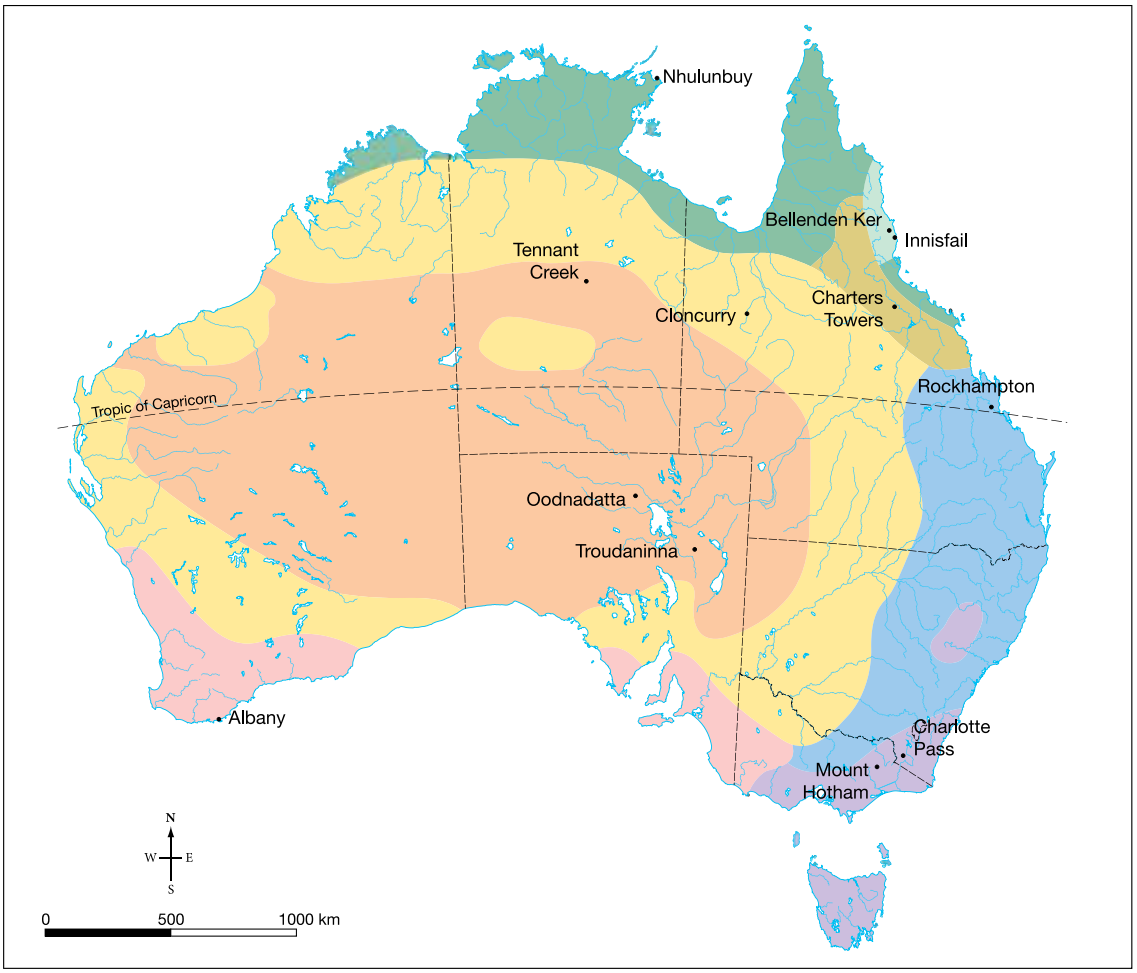


FIGURE 2 Structure of the Earth's atmosphere (not to scale)



FIGURE 3 Climatic zones of Australia



Key

Climatic zones

- Tropical wet and dry — Hot all year; wet summers; dry winters
- Tropical wet — Hot; wet for most of the year
- Subtropical wet — Warm; rain all year
- Subtropical dry winter — Warm all year; dry winters
- Mild wet — Mild; rain all year
- Subtropical dry summer — Warm all year; dry summers
- Hot semi-desert — Hot all year; 250–500 mm of rain
- Hot desert — Hot all year; less than 250 mm of rain

Source: Spatial Vision

12.9.2 Weather and climate: what is the difference?

Weather is the day-to-day, short-term change in the atmosphere at a particular location. Extreme weather events are often described as unexpected, rare or not fitting the usual pattern experienced at a location.

Climate is the average of weather conditions that are measured over a long time. Places that share the same type of weather are said to lie in the same climatic zone. Because of the size of the Australian continent, its climate varies considerably from one region to another. Synoptic charts provide a visual representation of weather information for a place including rainfall, wind and air pressure. Examine SkillBuilder 12.10 'Reading a synoptic chart' in your eBookPLUS to learn more about how to read a synoptic chart, or weather map.

ACTIVITIES

IDENTIFY

1 What is the name of the layer of the atmosphere where all Earth's weather happens?
2 Define the term *troposphere*.
3 In which levels of the atmosphere are the following features found?
   a Most passenger planes
   b Orbiting satellites
   c Burning meteors
   d The Aurora lights

EXPLAIN

4 Explain the difference between weather and climate.
5 Draw three diagrams to help you explain the factors that influence the following weather conditions:
   a air temperature
   b air movement
   c the amount of water in the air.

APPLY

6 In a magazine or newspaper or online, find a photograph that shows an example of one type of weather. Paste the picture in the centre of a page and add labels about the impact of that weather on the ***environment*** (for example, creating puddles) and on what we do (such as the clothes people wear).

PREDICT

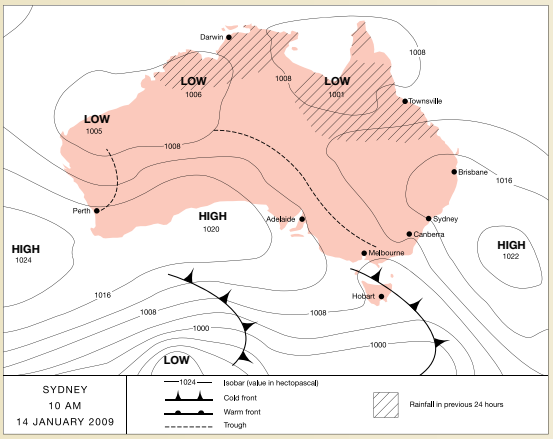
7 Look carefully at the photographs in figure 1.
   a Describe the weather event in each photograph.
   b How would each weather event affect people's lives?
8 Look carefully at the map of Australia's climatic zones in figure 3. Predict which two settlements, or ***places***, might be at risk of flood. Make sure you explain why you chose them.
9 Look at the ***environment*** outside the window.
   a What is the weather like? Do you think it matches the climatic zone in which you live? Explain.
   b Now check to see, using figure 3. If your answers are different, explain why this may have occurred.
10 Describe how the weather affected you yesterday.

eBook*plus* ONLINE ONLY

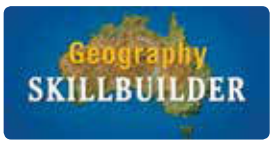
12.10 SkillBuilder: Reading a synoptic chart

What are synoptic charts?

Synoptic charts, or weather maps, show weather conditions over a larger area at any given time. They appear every day in newspapers and on television news. Being able to read a synoptic chart is a useful skill because weather affects our everyday life.



eLesson
Watch this video to learn how to read a synoptic chart.



Searchlight ID: eles-1637

Interactivity
Try this interactivity to learn how to read a synoptic chart.



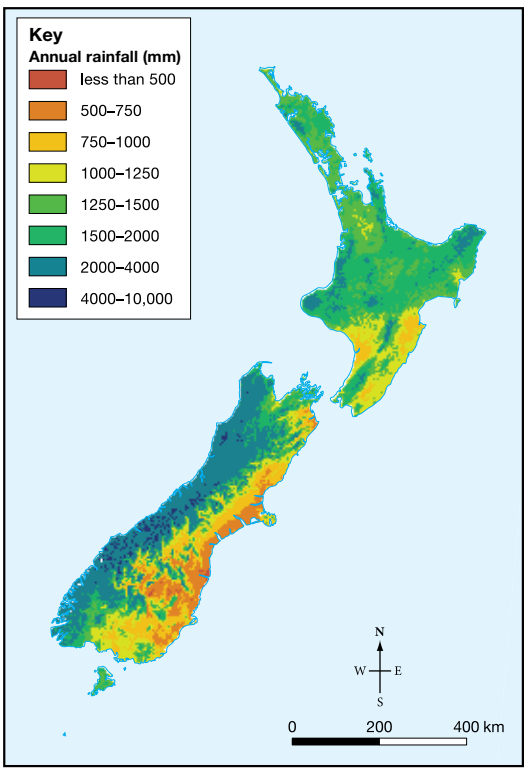
Searchlight ID: int-3133

12.11 How does water flow down the Haast River?

12.11.1 New Zealand's Haast region

Haast is a World Heritage site located on the west coast of the southern island of New Zealand (see figure 1). The region is untamed, with majestic mountains, pristine lakes and rugged coastlines. The Haast River discharges as much as 6 cubic kilometres of water annually, and the catchment extends into the Southern Alps. There are some areas of seasonal and permanent snows and very high rates of run-off in the region due to the steep mountainous terrain (see figure 2).

FIGURE 1 Annual rainfall, New Zealand



Source: WorldClim

FIGURE 2 The Gates of Haast



ACTIVITIES

IDENTIFY

1 Name the feature located at:
- **a** GR 315134
- **b** GR 300152
- **c** GR 282138
- **d** GR 313126.

2 State the height of:
- **a** Mt Swindle spot height in AR3013
- **b** Plover Crag spot height in AR3114
- **c** Mosquito Hill spot height in AR2813.

3 What is the local relief in AR2813?

4 Describe the location of swamp areas found in the Haast region.

5 Examine figure 1. Would you describe Haast as being in a high, medium or low rainfall area?

EXPLAIN

6 A tributary is a stream that flows into a larger river. Why are there so many tributaries that flow into the Haast River?

7 The Gates of Haast (unlabelled) are located at GR 310117. Examine figure 2 and then locate the Gates of Haast on the topographic map, figure 3. Explain the reasons for a high volume of river flow in this area.

APPLY

8 Explain how each of the following factors could affect water availability in the Haast region.
- **a** Latitude
- **b** Altitude
- **c** Topography
- **d** Climate change

9 With reference to the locations listed in questions 1–4, describe how the water cycle might function in this region.

PREDICT

10 Possible impacts of climate change are increased rainfall in north-eastern New Zealand and reduced snow cover. Consider how this may affect river flow in the Haast region. Predict the possible impacts of this for local communities and environments.

FIGURE 3 Topographic map extract of Haast, New Zealand



Source: LINZ Data Service. License: Creative Commons Attribution 3.0 New Zealand
https://data.linz.govt.nz/license/attribution-3-0-new-zealand/

eBookplus ONLINE ONLY

12.12 Why does the wind blow?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

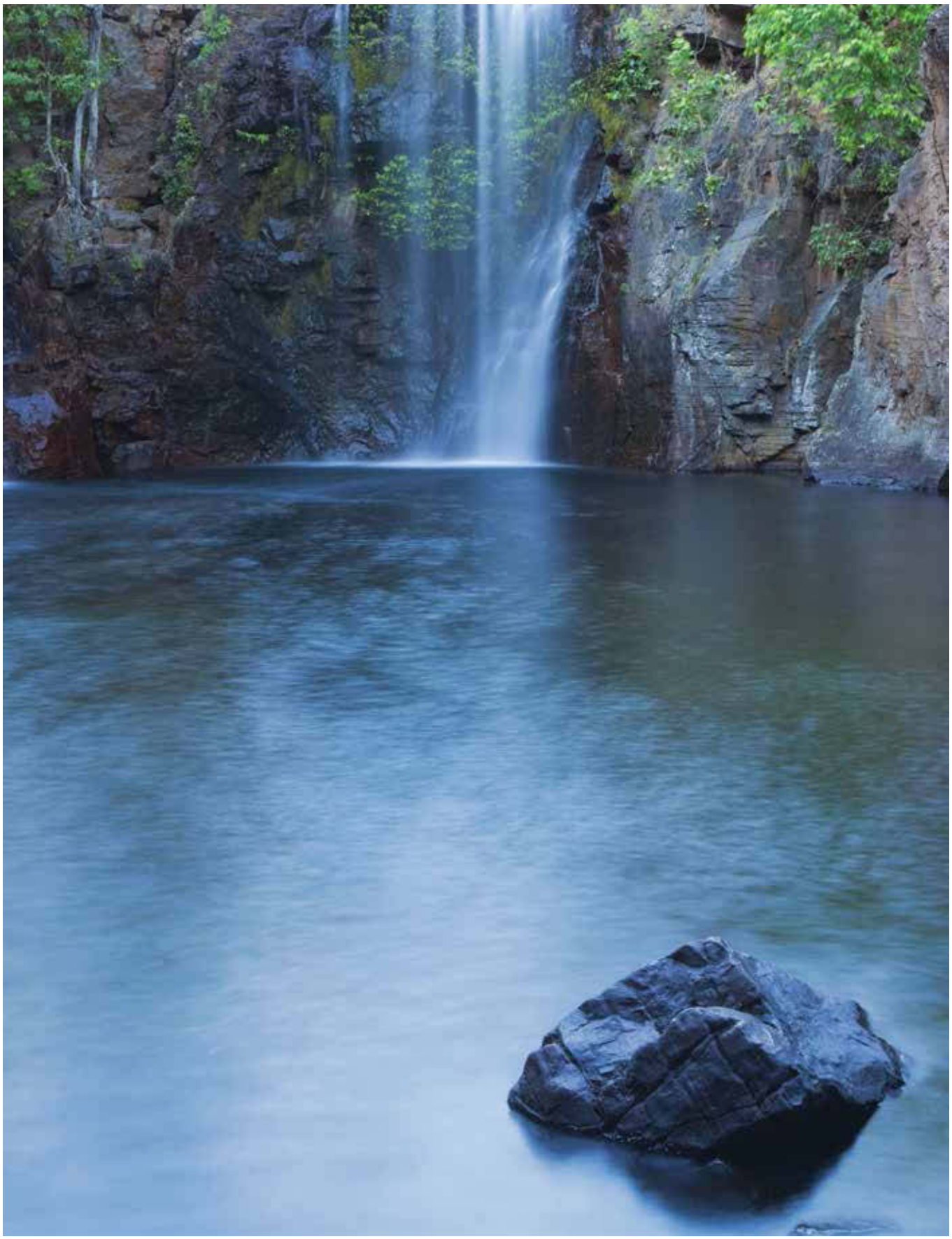
12.13 How strong is the wind?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

12.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



12.4 SkillBuilder: Interpreting diagrams

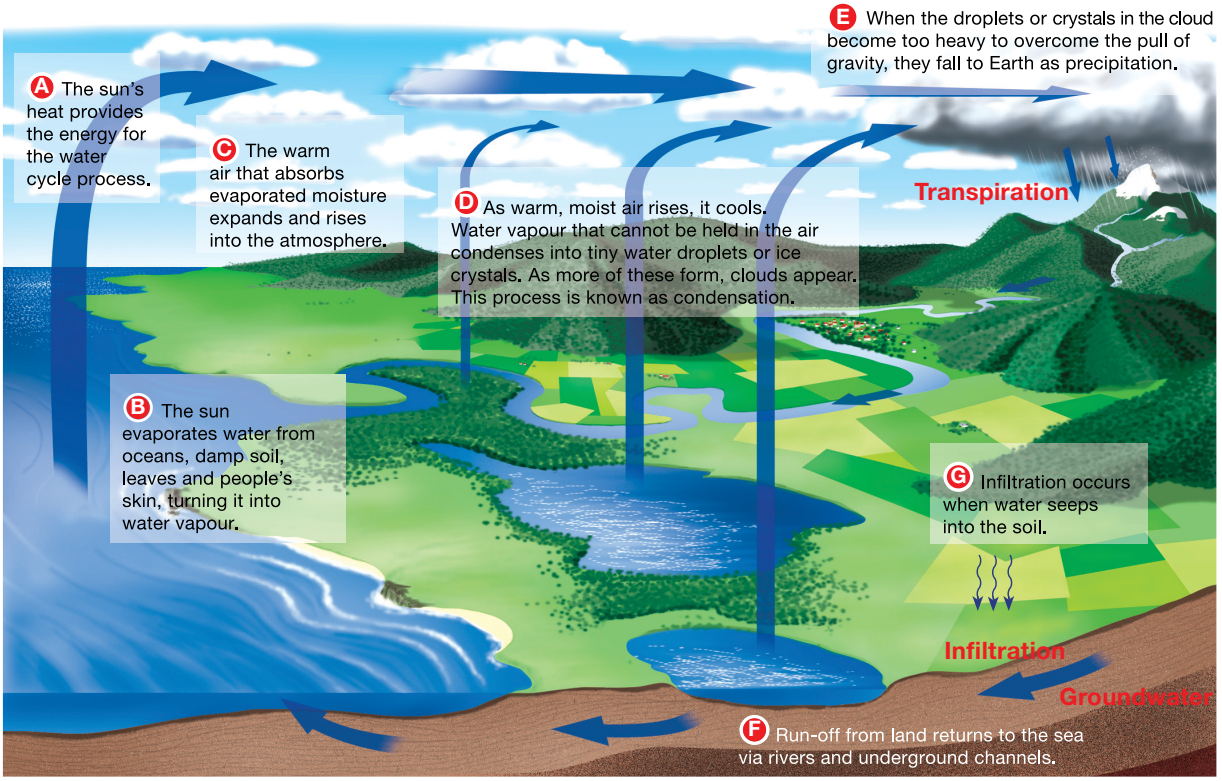
12.4.1 Tell me

What are diagrams?

A diagram is a graphic representation of something. In geography, it is often a simple way of showing the arrangement of elements in a landscape and the relationships between those elements. A common diagram that you are probably familiar with is the water cycle. Diagrams also have annotations: labels that explain aspects of the illustration.

What causes rainfall? Where does the water come from and where does it go? The answers lie with the water cycle. Water evaporates from oceans, lakes and vegetation, and condenses into clouds. The rain, sleet, hail or snow that falls from clouds flows back into rivers, lakes and oceans and underground, where the water cycle process continues.

FIGURE 1 The water cycle



Why are diagrams useful?

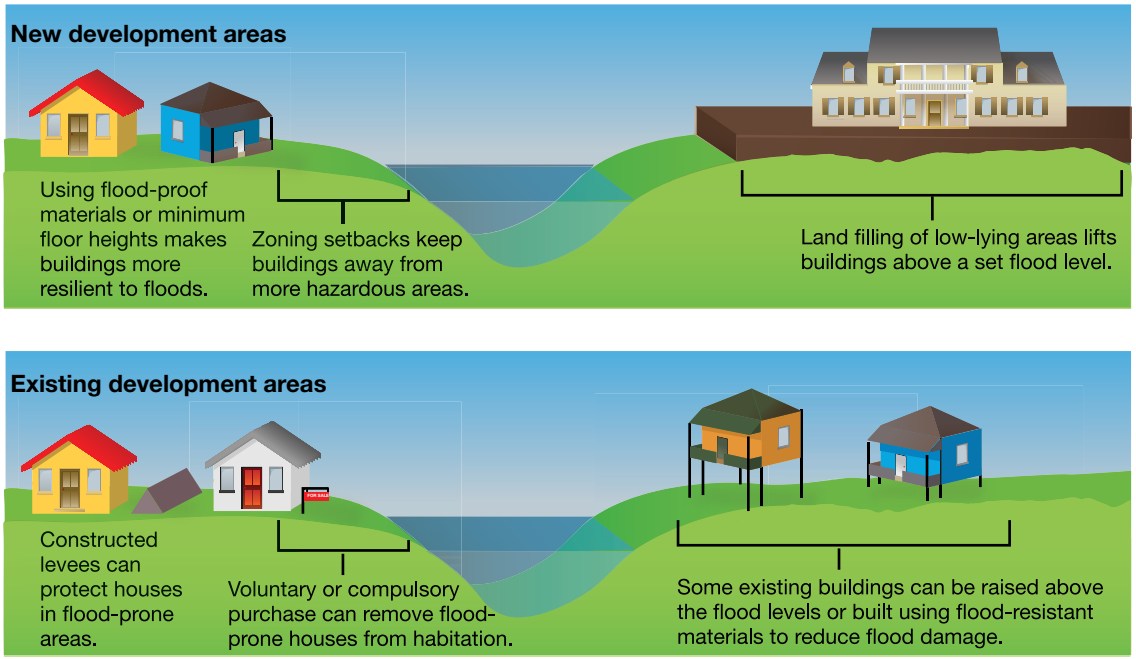
Diagrams are useful for showing ideas visually. They are often used to increase understanding of written information. They can be used to:

- illustrate a process
- simplify a concept
- show flows and movements
- illustrate relationships spatially.

Model

The diagram in figure 2 shows how properties can be designed to manage floods in new development areas and existing development areas.

FIGURE 2 Managing flood risks



A good diagram:

- is large so it can be easily interpreted
- has understandable annotations or labels
- is clear and simple
- includes a precise title or caption
- states the source — where it came from or who created it.

12.4.2 Show me

How to interpret a diagram

You will need:

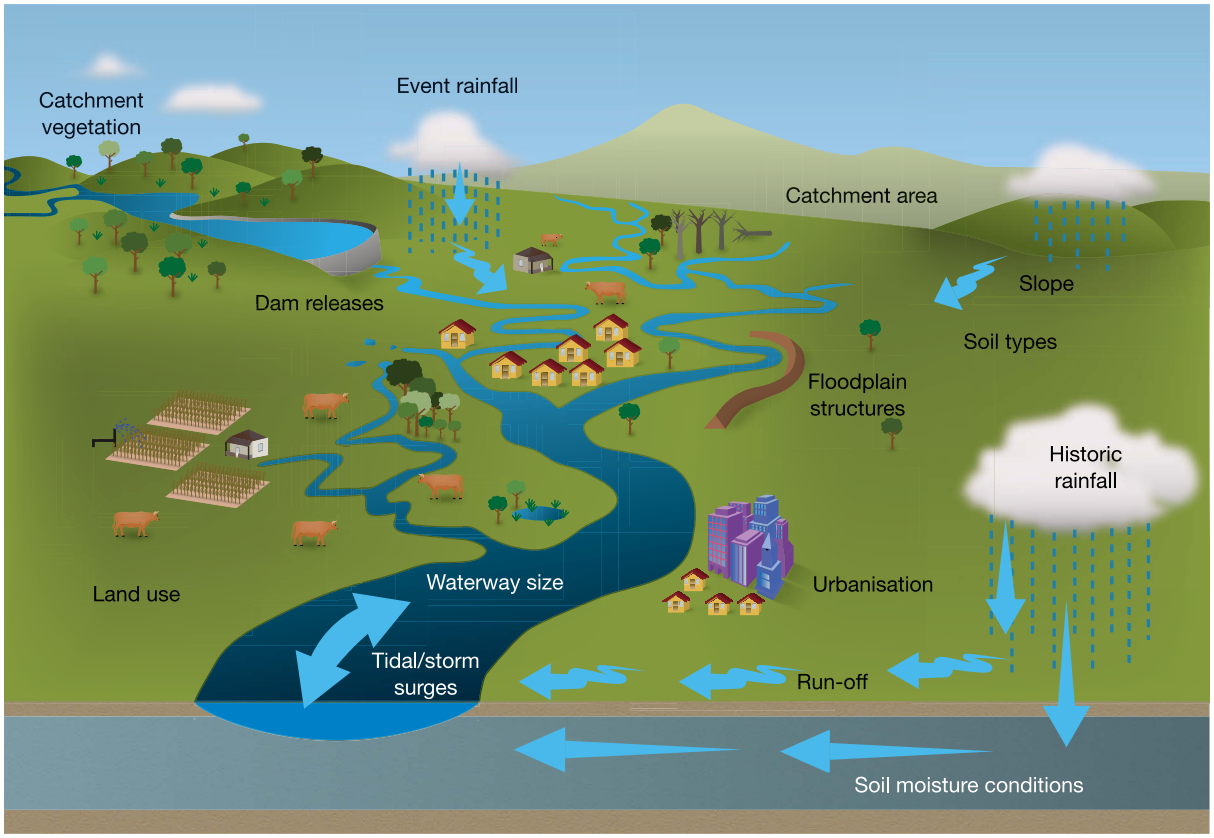
- a diagram
- any information that is related to the diagram.

The amount and intensity of rainfall is the most important factor in causing a flood, but there are many other factors that can contribute to flooding. When it rains in a catchment, the amount of rainwater that flows into the rivers depends on land uses. Some water can soak into soil unless the soil is already saturated from historic rainfall. Urban areas have many hard surfaces like roads so water cannot soak into the soil and more water flows into drains and creeks. Heavy vegetation can slow the movement of water to rivers. Dams can be used to control the amount of water released downstream. The shape of the land is also an important factor, because more water usually runs off steep slopes.

eBookplus

eLesson
Interpreting diagrams
Searchlight ID: eles-1636

FIGURE 3 Factors that can affect flooding



Procedure:

STEP 1

Identify and carefully read the *title* of the diagram, as it helps you to understand the purpose of the diagram. This diagram (figure 3) is illustrating factors that can affect flooding, and it is designed to be read with an explanation.

STEP 2

Examine the diagram to identify all the elements being illustrated and the annotations. Look at each *part* of the diagram. You will notice that rainfall is shown, vegetation is mentioned, run-off is illustrated in different areas of the catchment, and the size of waterways or rivers will affect flooding.

STEP 3

Now consider the diagram as a *whole*. We can conclude that there are many factors that affect flooding. It is more complicated than simply how much rain falls and how quickly. We now understand that releasing water from a dam can regulate how much water is flowing in the river downstream.

eBook*plus*

Interactivity
Interpreting diagrams
Searchlight ID: int-3132

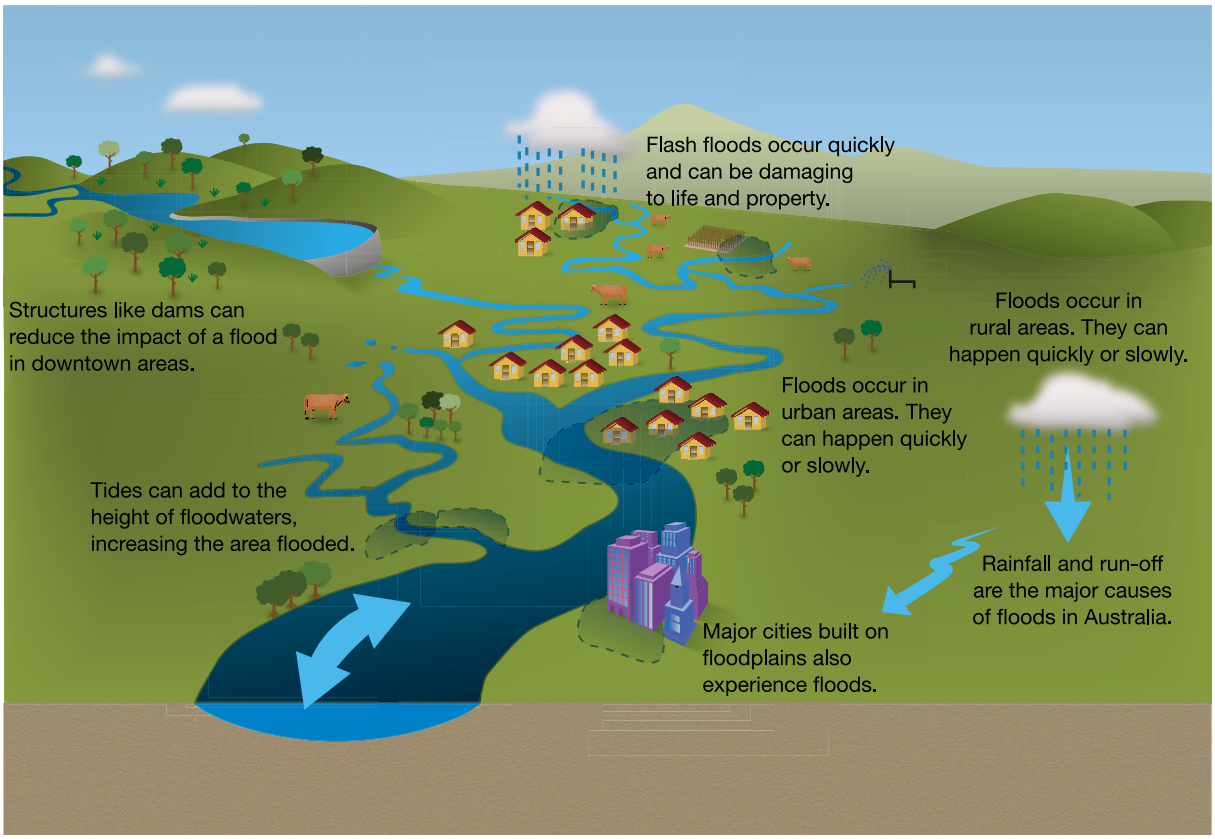
12.4.3 Let me do it

Developing my skills

Using figure 4, answer the questions that follow.

The main cause of flooding in Australia is rainfall. Floods can happen quickly (flash flooding) or slowly, and they are difficult to predict. Cities and farms are often built on floodplains (land that is subject to occasional flooding) because they provide access to water and good quality soil. In coastal areas, tides can add to flooding.

FIGURE 4 Characteristics of floods



Questions

1. How might a dam affect flood events?
2. What is run-off?
3. What effect can high tides have during flooding in coastal areas?
4. Why are cities sometimes built on floodplains?
5. What are some effects of floods?

Checklist

I have:

- understood the title
- examined all parts of the diagram — the illustrations, annotations and any accompanying text
- considered the diagram as a whole.

Skills questions

1. Diagrams are used to:
   a. show a process
   b. make a concept easier to understand
   c. illustrate flows and movements
   d. all of the above.
2. A diagram should be:
   a. as small as a postage stamp
   b. large, so it can be easily read
   c. understandable without the title
   d. anonymous, with no statement of a source.
3. Why is the water cycle such an important diagram to understand?
4. Why are features such as cities, towns and farms not drawn to ***scale*** in diagrams?

12.5 How much water is there in the world?

12.5.1 The world's water

Water is vital to our survival and essential to most human activities. Although Earth seems blue in space, not much of the water we see is available for use. And of the useable fresh water that can be seen, access to it is unequal across the globe.

Water covers about 75 per cent of the Earth's surface. Yet, as figure 2 shows, almost all this water (97.5 per cent) is salt water and not available for human consumption. Only 2.5 per cent of the world's water is fresh, but most of this is also unavailable for use by people. More than two-thirds (69.5 per cent) of this fresh water is locked up in glaciers, snow, ice and permafrost. Of the remaining amount, 30.1 per cent is found in groundwater. Only 0.4 per cent is left — found in rivers, lakes, wetlands and soil as well as in the bodies of animals and plants.

Global rainfall

The Earth's water is constantly moving. Rainfall patterns show which world regions receive more rain than others. The amount of rainfall, or **precipitation**, is related to the amount of water available for use by people.

Green and blue water

The key to our survival is being able to use the water that falls on land and into rivers and streams. Water is sometimes categorised as either **blue water** or **green water**.

Green water is the water that does not run into streams or recharge groundwater but is stored in the soil or stays on top of the soil or vegetation. This water eventually evaporates or transpires through plants. Green water is used by crops, forests, grasslands and savannas.

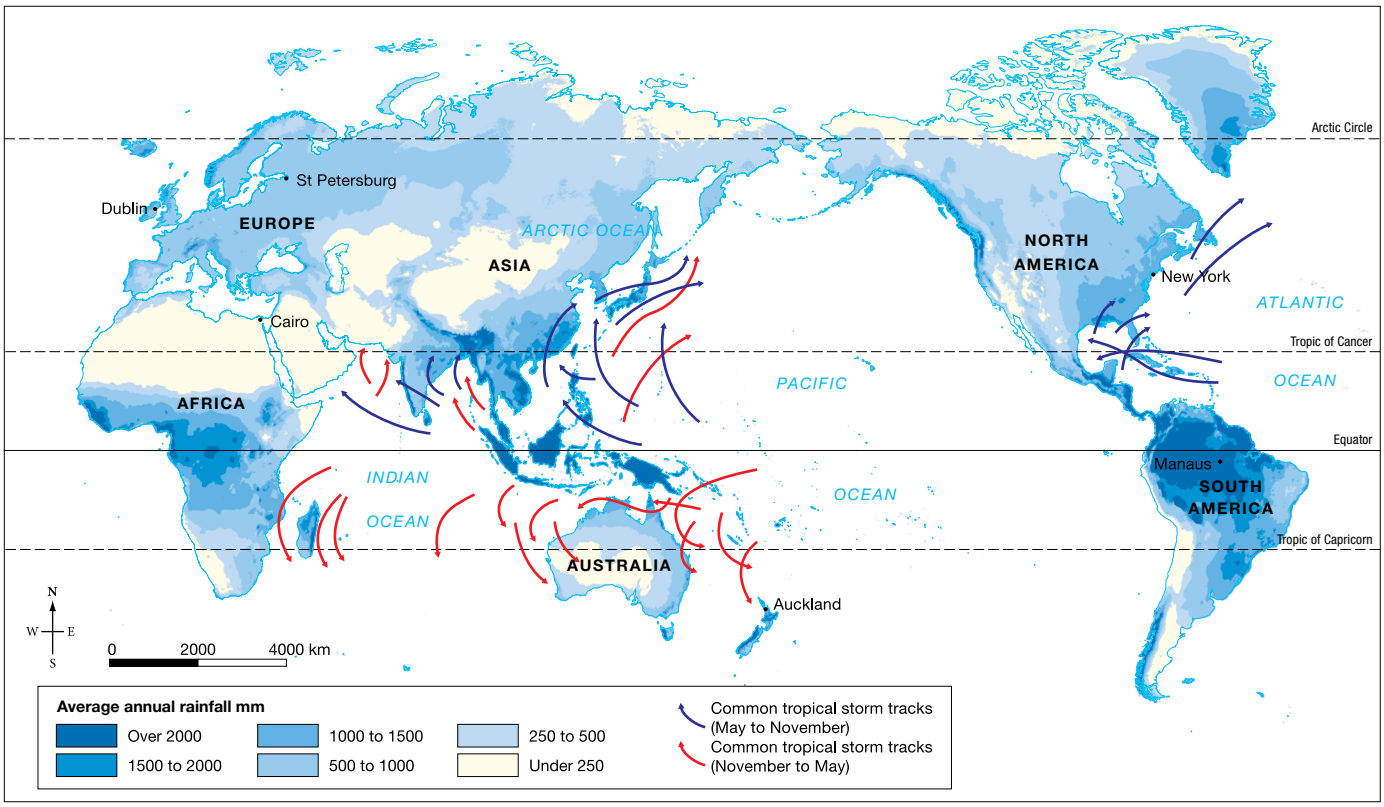
The amount of blue and green water available changes throughout the year, from year to year, and according to changes in the environment.

precipitation rain, sleet, hail, snow and other forms of water falling from the sky when water particles in clouds become too heavy

blue water the water in freshwater lakes, rivers, wetlands and aquifers

green water water that is stored in the soil or that stays on top of the soil or in vegetation

FIGURE 1 The distribution of global rainfall



Source: WorldClim

FIGURE 2 The distribution of water on Earth

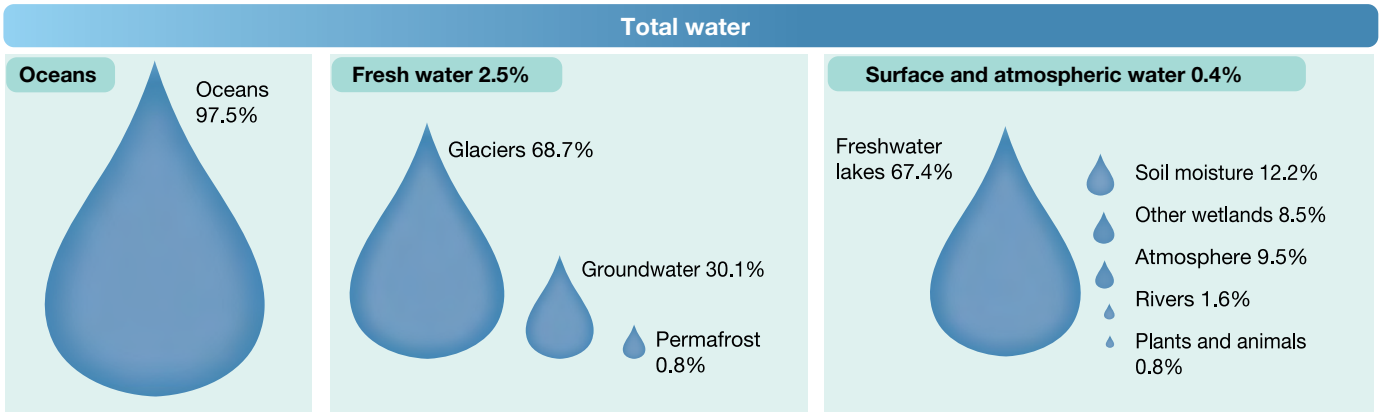
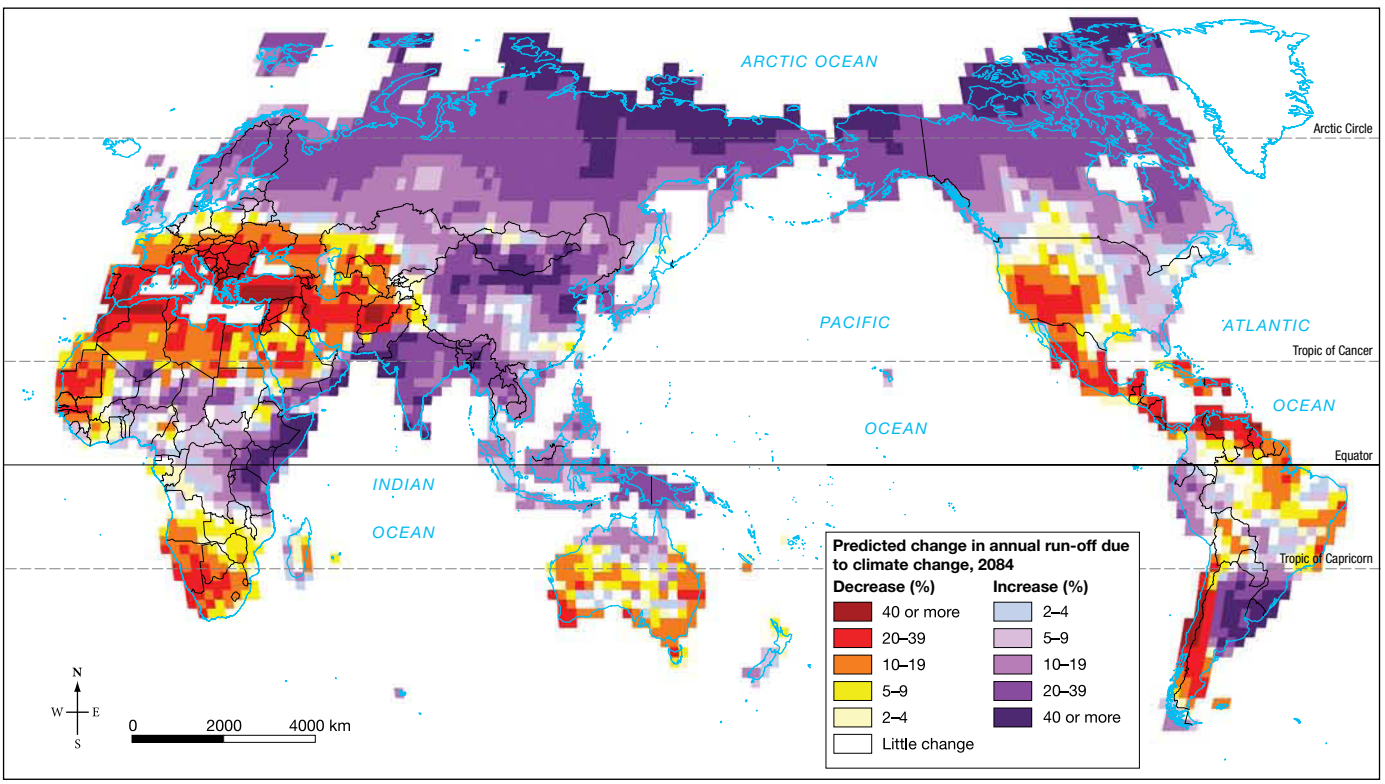


FIGURE 3 Predicted change in annual run-off due to climate change, 2084



Source: Geophysical Fluid Dynamics Labratory, National Oceanic and Atmospheric Administration

climate change a change in the world's climate. This can be very long term or short term, and can be caused by human activity

run-off precipitation not absorbed by soil, and which runs over the land and into streams

12.5.2 Climate change and impact on rainfall and run-off

The majority of climate scientists believe that **climate change** will have an impact on rainfall patterns and **run-off**. Climate models have shown that areas in the northern latitudes are likely to experience more rain, and areas closer to the equator and mid-latitudes will receive less rain. Some regions will experience droughts, while others will experience high rainfall and even flooding.

Over the last 100 years, global rainfall patterns have changed. In some areas such as North America, South America, northern Europe and northern and central Asia, rainfall has increased significantly. In other areas such as the Sahel, the Mediterranean, southern Africa and parts of Asia, rainfall has decreased.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› Retreating glaciers
› World water resources

ACTIVITIES

IDENTIFY

1 What percentage of the world's water is:
   a salty
   b available for use by people?
2 How will climate ***change*** affect rainfall patterns?

EXPLAIN

3 Study figures 1 and 3 and use the **Regions** resource in the Resources tab.
   a Describe how much rain falls in North Africa and West Asia (the Middle East). How does this compare with Australia?
   b What is predicted to happen to annual run-off in these regions as a result of climate ***change***? What impact might this have on people and the ***environment***?
4 Write a statement about the ***interconnection*** between high rainfall and location at the equator and mid-latitudes. Name two ***places*** that do not fit this pattern.
5 Use the text to outline the difference between blue and green water. List two things that might ***change*** the amount of blue and green water available.
6 If farmers use irrigation, what type of water would they rely on? What about farmers who do not have access to irrigation?

PREDICT

7 Work in groups of three to list what might happen to people and the ***environment*** in regions that:
   a will receive more rainfall than they do now
   b will receive less rainfall than they do now.
   Complete a consequence chart for each ***change***.

INVESTIGATE

8 Study figure 3 and an atlas.
   a Name three ***places*** that are predicted to receive more run-off due to climate ***change***.
   b Name three ***places*** that are predicted to receive less run-off due to climate ***change***.
   c Compare these six ***places*** with the global rainfall map, figure 1. Which of the following statements is true? (Rewrite any false ones and make them true.)
      - Most ***places*** with very low rainfall have lower run-off.
      - All ***places*** with very high rainfall experience increased run-off.
      - The ***places*** with the greatest ***change*** in run-off will be northern Russia and northern Canada.

eBook*plus*

Digital doc
Regions
Searchlight ID: doc-17950

12.10 SkillBuilder: Reading a synoptic chart

12.10.1 Tell me

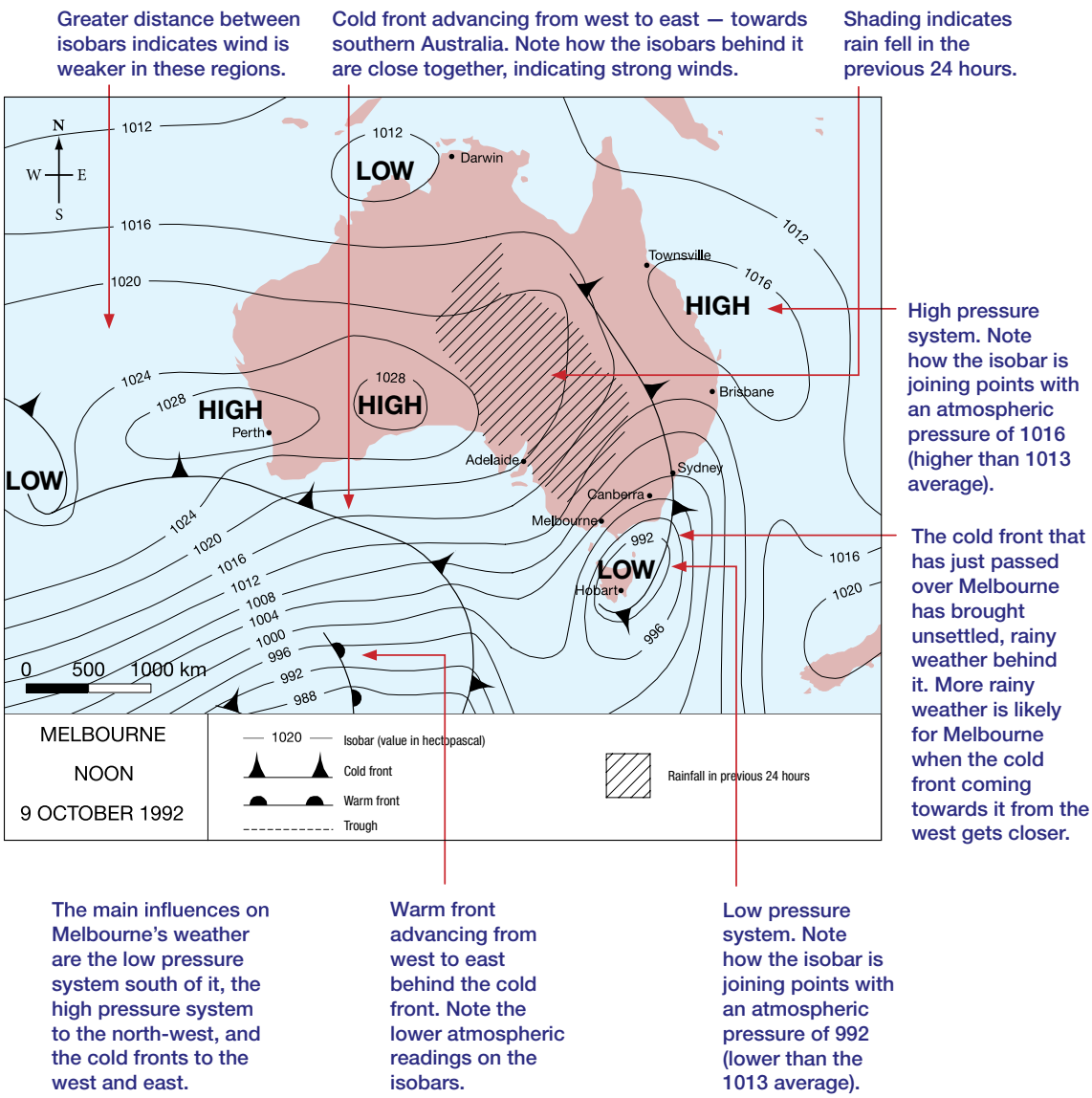
What are synoptic charts?

Weather maps or synoptic charts appear every day in newspapers and on television news (see figure 1). They may look complex but, just as you learned to read letters and words, you can quickly learn to read the symbols on weather maps. Once you understand the symbols, you will find these maps easy to use.

Why are synoptic charts useful?

Understanding weather is useful because it affects everyone's lives. Farmers use weather information to plan their work; tourists rely on forecasts to make decisions about travel plans; and emergency services use weather forecasts to broadcast warnings so that people can prepare for adverse conditions.

FIGURE 1 A typical synoptic chart



Source: MAPgraphics Pty Ltd, Brisbane

Today, people who study and predict weather (called meteorologists) have more accurate ways of predicting weather than those used in the past. They make use of satellite images, radar-tracking weather balloons, automatic weather stations, ships and aircraft.

Model

Synoptic charts use lines and symbols to show areas of low and high pressure and weather events such as warm and cold fronts. The lines are called isobars. They join places with the same atmospheric pressure. Atmospheric pressure is the weight of the air. Humans cannot accurately feel differences in air weight. Atmospheric pressure varies from place to place, depending on the temperature of the air. Meteorologists use very sensitive instruments called barometers to measure atmospheric pressure.

The average weight of air is 1013 hectopascals (hPa). Measurements higher than this (such as 1020 hectopascals) indicate areas of high atmospheric pressure, where air is sinking. Measurements lower than this (such as 985 hectopascals) indicate areas of low atmospheric pressure, where air is rising. Let's use this code to read the synoptic chart in figure 2.

eBook*plus*

eLesson
Reading a synoptic chart
Searchlight ID: eles-1637

12.10.2 Show me

How to interpret a synoptic chart

You will need:

- a synoptic chart.

Procedure:

To identify features on a synoptic chart, you need a key to interpret the symbols.

TABLE 1 Symbols on synoptic charts for the southern hemisphere

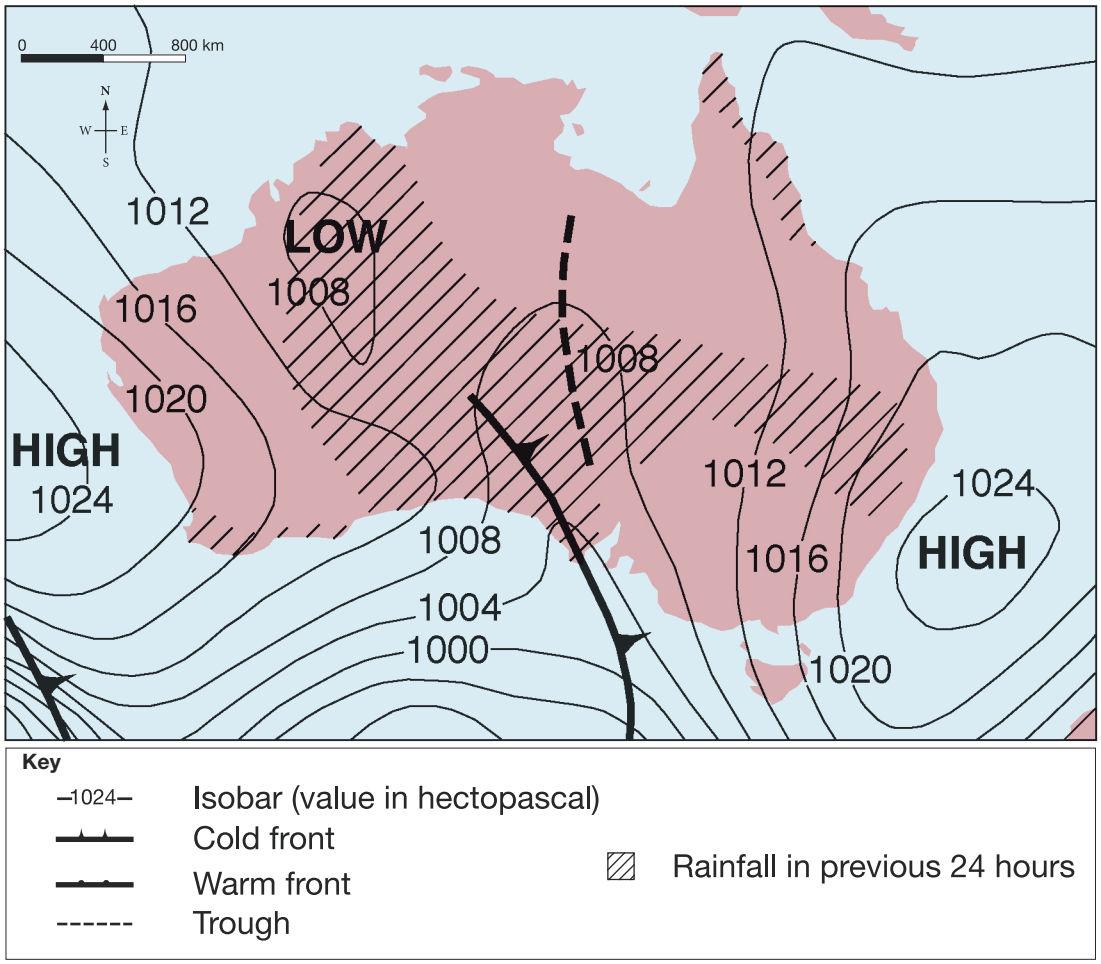
Symbol	Name	What does it mean?	Comment
	Isobars	Join places of same air pressure	The closer together these lines, the stronger the wind.
	High pressure area	Sinking air	Generally fine weather. Winds rotate around these areas anticlockwise.
	Low pressure area	Rising air	Generally cooler weather, rain. Winds rotate around these areas clockwise.
	Tropical cyclone	Rapidly rising air	Strong winds, torrential rain
	Cold front	The 'line' along which an approaching mass of cold air meets warmer air	Fall in temperature, rain. Front moves in direction of arrowheads.
	Warm front	The 'line' along which an approaching mass of warm air meets colder air	Temperature rise, sometimes light rain. Uncommon in Australia.
	Rain	Rain in the last 24 hours	Usually associated with low pressure areas and fronts
	Trough	A dip in isobars	An area associated with unsettled weather and precipitation

STEP 1

Pressure systems

Examine high pressure systems (pressure above 1013 hectopascals) and low pressure systems (pressure below 1013 hectopascals). Pressure systems generally move from west to east as they cross Australia and move around the world. In figure 2 there is a high-pressure system approaching south-west Western Australia, and this system is likely to bring fine weather to the region. The low-pressure system east of Broome brings cooler weather and rain.

FIGURE 2 Synoptic chart for 10 November 2002



Source: MAPgraphics Pty Ltd, Brisbane

STEP 2

Air masses and fronts

Examine any air masses and fronts. In figure 2 there is a cold front where cold air meets warmer air. This is likely to cause a fall in temperature and rain in South Australia.

STEP 3

Precipitation

Examine precipitation patterns. Precipitation includes snow, hail and dew but the most common form of precipitation is rainfall. In figure 2, over half of Australia has received rain in the last 24 hours. This chart does not indicate how much rain fell.

STEP 4

Wind

Wind is not depicted on this synoptic chart. However, the closer together the isobars are, the stronger the winds. There are no significant areas of high wind in Australia on 10 November.

STEP 5

Troughs

The synoptic chart in figure 2 shows a trough in central Australia. The trough line runs north from central South Australia towards the Gulf of Carpentaria. Troughs are usually associated with unsettled weather and precipitation.

eBook*plus*

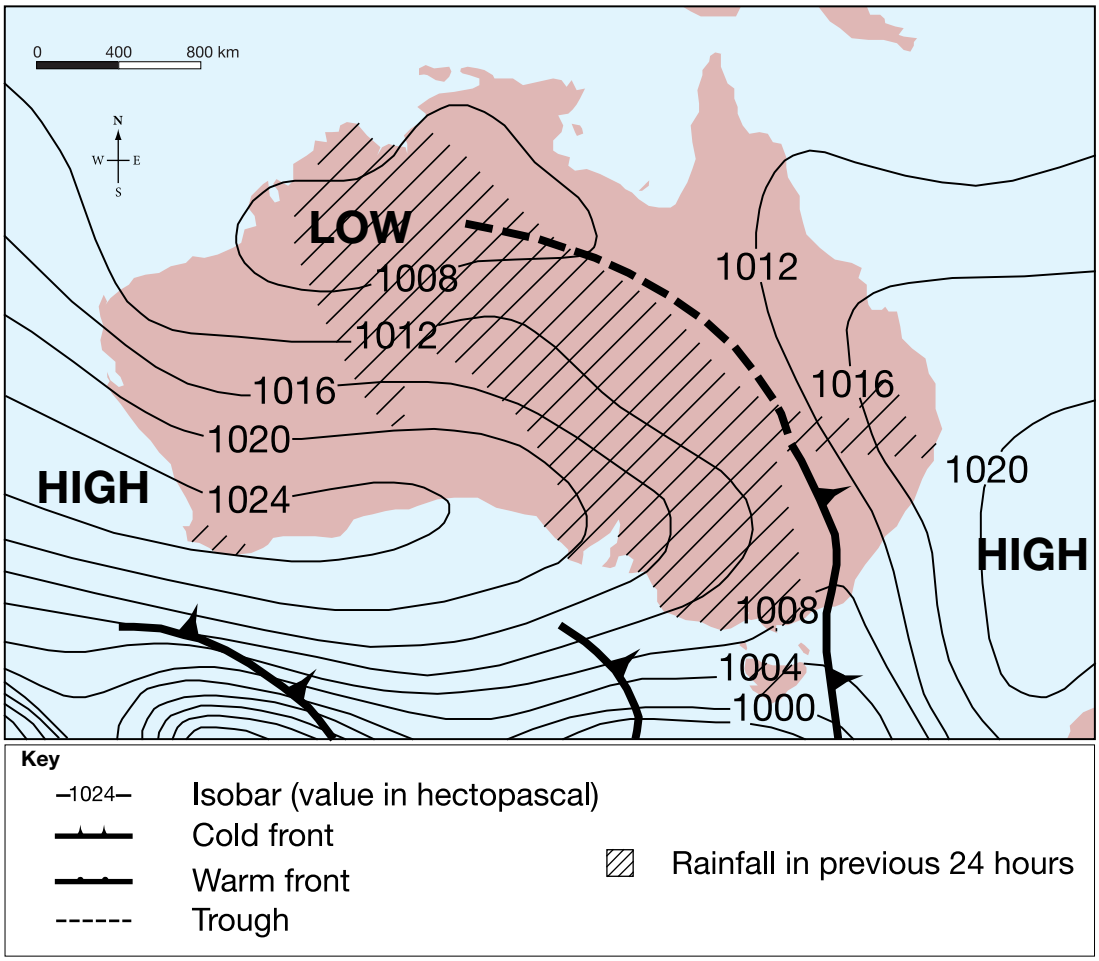
Interactivity
Reading a synoptic chart
Searchlight ID: int-3133

12.10.3 Let me do it

Developing my skills

The map in figure 3, produced on 11 November, predicts the weather for 12 November.

FIGURE 3 Synoptic chart showing predicted weather for 12 November 2002



Source: MAPgraphics Pty Ltd, Brisbane

Questions

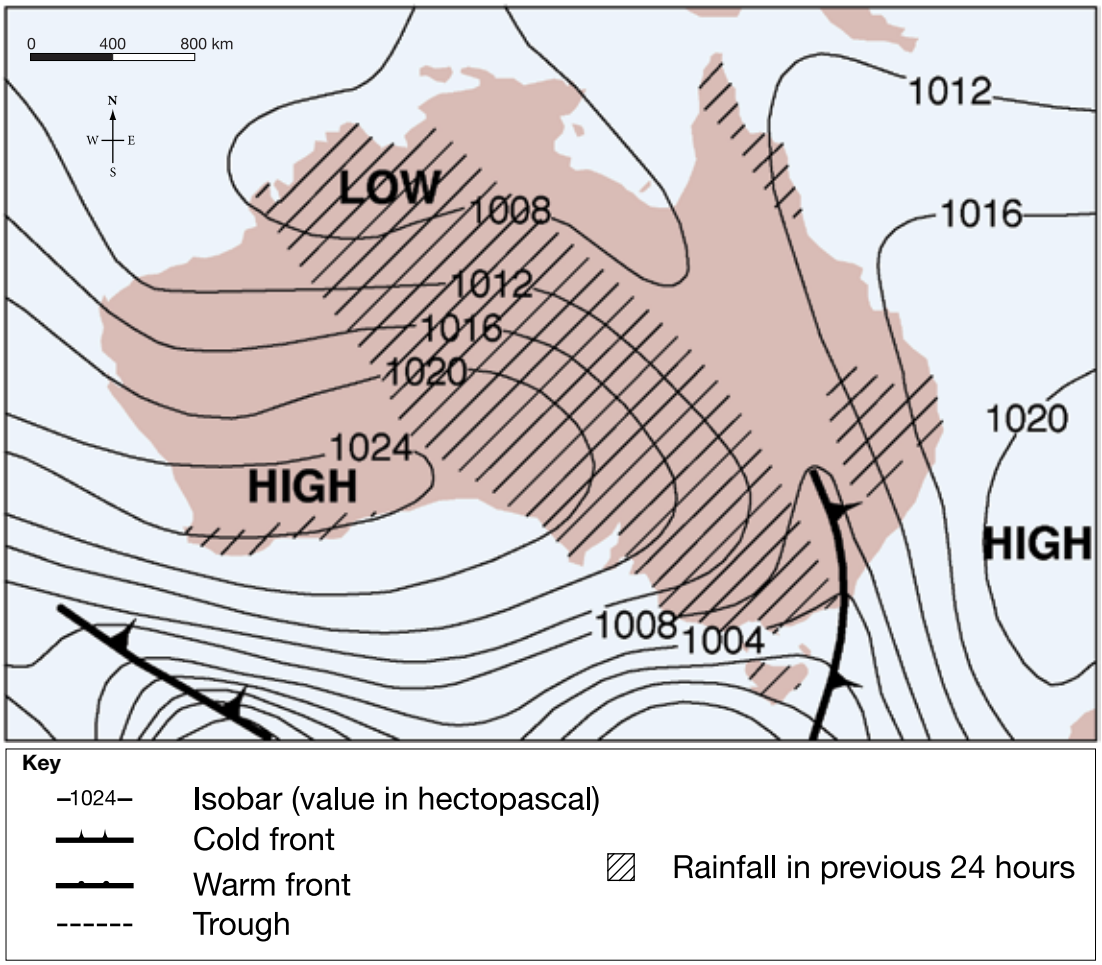
1. List what is different from the previous day's synoptic chart shown in figure 2.
2. Compare the actual weather conditions in figure 4 with those predicted 24 hours earlier in figure 3.
   a. How accurate was the predicted weather map?
   b. Where was it different?
3. Using figure 4, describe Melbourne's weather on 12 November.

Checklist

I have:

- interpreted pressure systems, air masses and fronts, precipitation, wind and troughs
- written a detailed description.

FIGURE 4 This map shows what the weather was actually like on 12 November 2002.



Source: MAPgraphics Pty Ltd, Brisbane

Skills questions

1. When isobars are close together, it means:
   a. expect a warm night
   b. there will be no clouds that day
   c. it will be very windy
   d. it will be cloudy.
2. The lines on a weather map, or synoptic chart, are called isobars. What do they join?
   a. Places with equal wind speeds
   b. Locations that have the same temperature
   c. Spots of similar climate
   d. Places of equal air pressure
3. Explain what isobars, cold fronts and low- and high-pressure systems are.
4. What changes in weather can be expected if a cold front arrives? Why?

12.12 Why does the wind blow?

12.12.1 Air has weight

Earth's atmosphere protects us from the extremes of the sun's heat and the chill of space, making conditions right to support life. The air in the lowest layer of the atmosphere is called the **troposphere**. Weather is the result of changes in this layer of the atmosphere.

troposphere the layer of the atmosphere closest to the Earth. It extends about 17 kilometres above the Earth's surface, but is thicker at the tropics and thinner at the poles, and is where weather occurs

The air around us has weight. The weight of the air above us pushes down on the surface, creating pressure. If we could tie a **barometer** to a hot air balloon, we would see the pressure readings fall as the balloon rose in the atmosphere. This is because there is less air higher up in the atmosphere. You may have read about mountain climbers and athletes having difficulty breathing when they are at high altitudes.

barometer an instrument used to measure air pressure

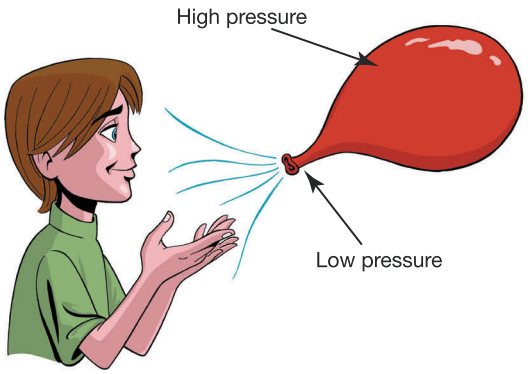
Air pressure

When a person blows up a balloon, the pressure inside the balloon is higher than the surrounding air. When the neck of the balloon is released, the air rushes out of the balloon, as shown in figure 1 (a) and (b). This is wind. If we did not have wind, temperatures would continue to rise over the equator and decrease at the poles.

FIGURE 1a The pressure inside a balloon is higher than the surrounding air.



FIGURE 1b When the neck of the balloon is released, air rushes out, moving from a space of high pressure to one of low pressure.



Meteorologists are able to measure air pressure using a unit of measure called a millibar. The average weight of air is about 1013 millibars. Measurements higher than this indicate areas of high pressure; here, the air is sinking. Measurements lower than 1013 millibars indicate areas of low pressure; here, the air is rising. Wind is caused by air moving from areas of high pressure to areas of low pressure.

meteorologist a scientist who studies the weather

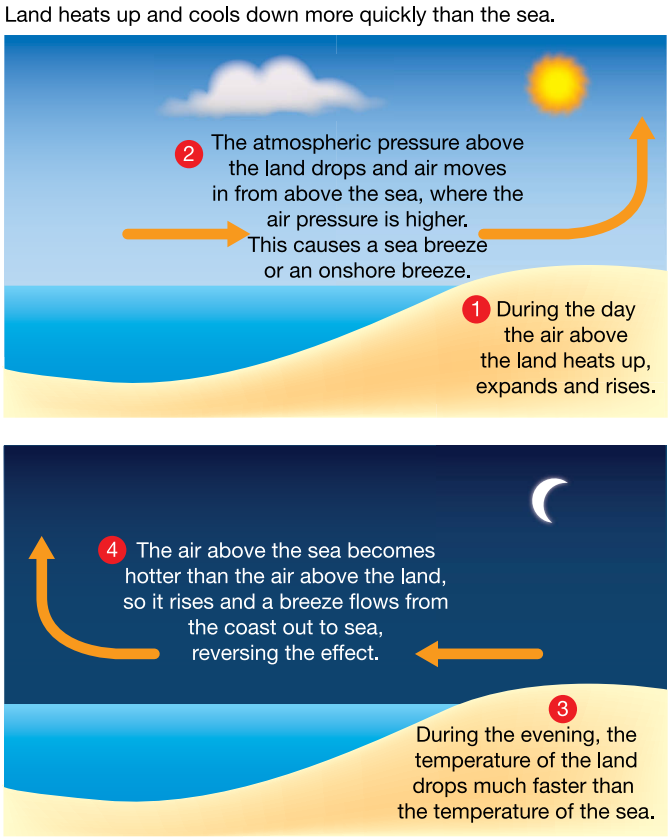
12.12.2 Why does air pressure vary across the Earth?

Variations in air pressure are the result of the heating effect of the sun and the rotation of the Earth.

Effects of the sun

The warming influence of the sun varies with the time of day (see figure 2) and latitude (distance from the equator). Temperatures are higher in the middle of the day, and higher at the equator than at the poles. Warm air is also less dense than cold air. This is because as the air heats, it expands, causing it to rise. Air pressure over the equator is less than at the poles. As the warm air over the equator rises and expands, cooler air from near the poles rushes in to replace it. As a result, air is circulated around the Earth, and this movement of air is what we call wind.

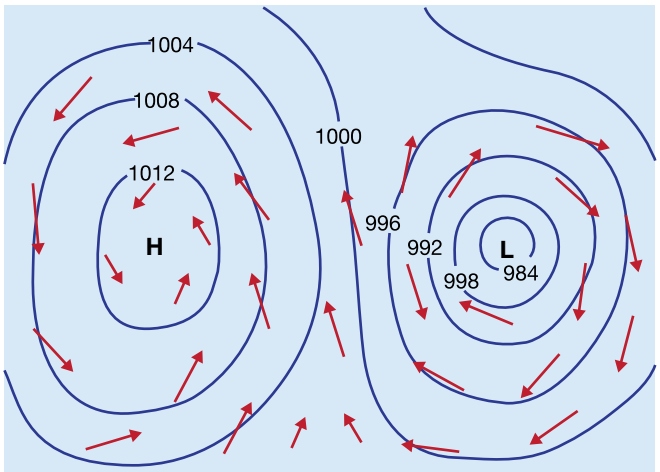
FIGURE 2 This diagram shows the effect of the sun on a sea breeze.



Effect of the Earth's rotation

The rotation of the Earth on its axis causes the air above the surface of the Earth to be deflected rather than to travel in a straight line. This causes the wind to circle around high and low pressure systems. The direction in which winds circle depends on whether you are in the Northern or Southern Hemisphere. As the air moves from an area of high pressure to an area of low pressure, winds circle in the opposite direction in each hemisphere. In an area of high pressure, the winds circle in an anticlockwise direction in the Southern Hemisphere and a clockwise direction in the Northern Hemisphere. This deflection of winds is known as the Coriolis effect (see figure 3).

FIGURE 3 Wind is caused by air moving from areas of high pressure to areas of low pressure. Its direction is influenced by the rotation of the Earth.



eBookplus

Interactivity
Highs and lows
Searchlight ID: int-3086

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Australia: weather and climate

ACTIVITIES

IDENTIFY

1 What is wind?

2 Identify the two factors that influence wind. Would either of these factors influence the strength of the wind? Explain.

EXPLAIN

3 Explain why you are not affected by the pressure of the atmosphere.

4 What role does the sun play in causing wind?

INVESTIGATE

5 Working with a partner, try the following activity to illustrate the influence of the Earth's rotation on wind.
Step 1. Place a pin through the centre of a piece of paper and attach it to a piece of cardboard. Make sure the paper can move freely on the pin.
Step 2. Have your partner rotate the piece of paper around the pin. At the same time, you should attempt to draw a straight line on the page.
Step 3. Record your findings.
Step 4. Compare and discuss your results with the class.

6 Over the course of the next week, collect weather maps from the daily newspaper and find your location.
- **a** Is the weather being influenced by a high or a low pressure system?
- **b** Will the wind be moving in a clockwise or anticlockwise direction? Give reasons for your answer.

7 Observe the wind conditions outside your classroom.
- **a** Is it windy today?
- **b** Identify the direction in which the wind is blowing.

PREDICT

8 How easy is it to predict the weather? People often complain that the forecasters don't always get it right.
- **a** Using the weather maps you collected earlier, and the observations you made, write a weather forecast for tomorrow. In your forecast, make reference to both wind speed and direction.
- **b** Collect tomorrow's weather map and make observations similar to those you made in question 6. Record your findings
- **c** Compare what you have written for this activity. How accurate were your predictions? Suggest factors that might influence the accuracy of such predictions and ***changes*** that you observe.

9 What is the ***interconnection*** between our atmosphere and the weather we experience at the Earth's surface?

12.13 How strong is the wind?

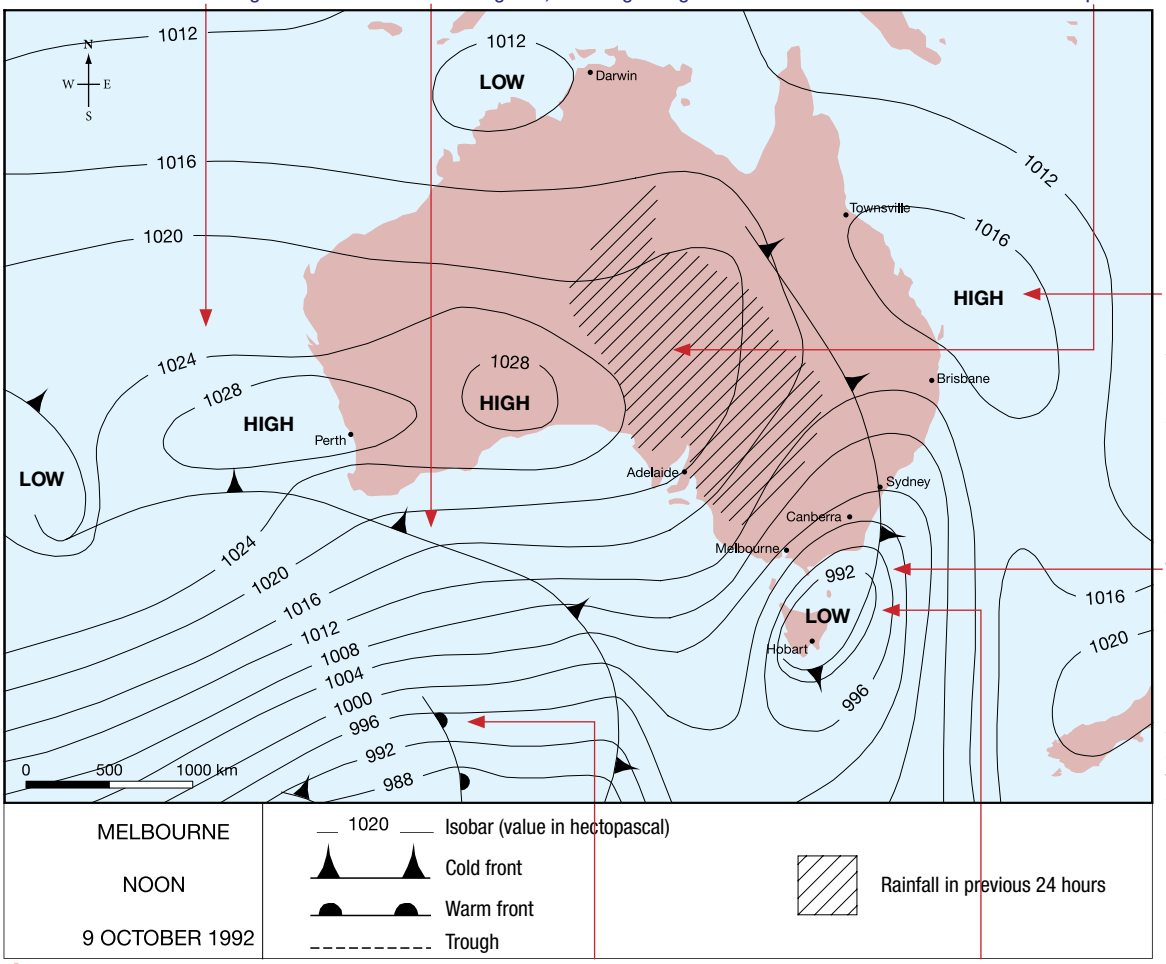
12.13.1 How is wind shown on a weather map?

Differences in air pressure lead to variations in the strength of the wind. You can work out the strength of the wind by looking at weather maps, the behaviour of objects or by using instruments designed to measure the strength of the wind. Winds are named according to their source. This means that a northerly wind is coming from the north and a southerly from the south.

If you study the **isobars** on a weather map you will notice that they are not evenly spaced. Look closely at the map in figure 1a. The wind is strongest in the southern regions of this map, where the isobars are close together, and gentler in the northern parts of the map, where the spacing between them is much greater. The symbols shown in figure 1b are also commonly used on weather maps to give a more accurate representation of wind speed and to provide information on the direction of the wind.

isobars lines on a map that join places with the same air pressure

FIGURE 1a A typical weather map



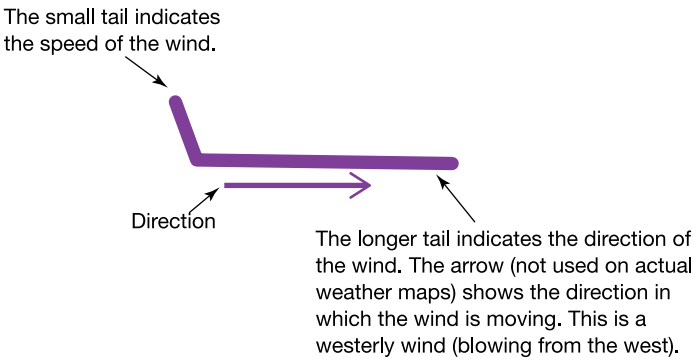
Typical weather map
The main influences on Melbourne's weather are the low pressure system south of it, the high pressure system to the north-west, and the cold fronts to the west and east.

Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 1b Symbols commonly used to indicate wind strength.

	Calm (0–2 km/h)		3–7 km/h		8–12 km/h
	13–17 km/h		18–22 km/h		23–27 km/h
	28–32 km/h		33–37 km/h		38–42 km/h
	43–47 km/h		48–52 km/h		53–57 km/h

FIGURE 1c How to read wind symbols on a weather map



Can I make observations about the speed of the wind?

The Beaufort scale (see figure 3) relates wind speed to the observable movement of objects within the environment.

Using a wind rose

A wind rose such as that shown in figure 2 uses data collected over long periods of time to visually represent wind information. The spokes represent wind direction; the longer the spoke the more frequently the wind blows from a particular direction. The thickness of the bands represents the speed of the wind. Refer to the SkillBuilder 'Cardinal points: wind rose' in subtopic 15.3 to learn how to use a wind rose.

FIGURE 2 A wind rose can show wind speed, direction and frequency over a long period of time.

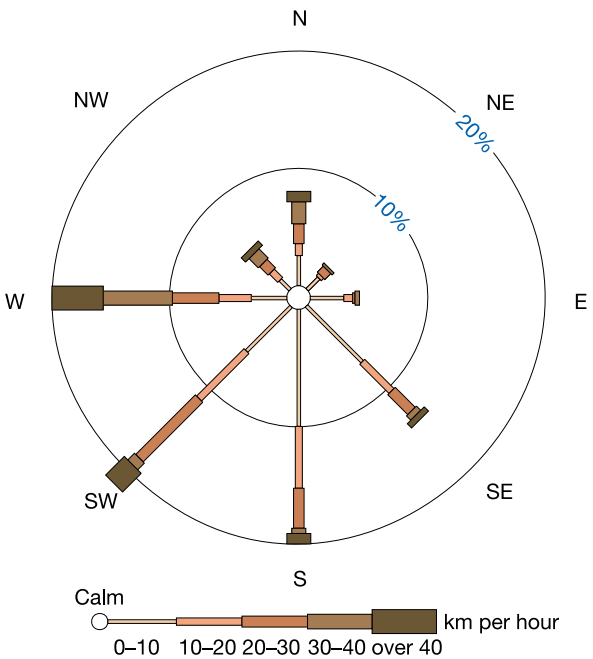


FIGURE 3 The Beaufort scale is based on the observable impact of winds.

0 Calm
Less than 2 km/h
Smoke rises vertically

2 Light breeze
6–12 km/h
Wind felt on face, wind vanes move

4 Moderate breeze
21–30 km/h
Dust and loose paper move, small branches move

6 Strong breeze
41–51 km/h
Large branches move, umbrellas difficult to use, difficult to walk steadily

8 Gale
64–77 km/h
Twigs broken off trees, difficult to walk

10 Whole gale
88–101 km/h
Trees uprooted, considerable structural damage

12 Hurricane/cyclone
Greater than 120 km/h
Widespread devastation



1 Light air
2–5 km/h
Smoke drift shows wind direction, wind vanes don't move

3 Gentle breeze
13–20 km/h
Leaves and small twigs in motion, hair disturbed, clothing flaps

5 Fresh breeze
31–40 km/h
Small trees with leaves begin to sway, wind force felt on body

7 Moderate gale
52–63 km/h
Whole trees in motion, inconvenience felt when walking

9 Strong gale
78–86 km/h
People blown over, slight structural damage, including tiles blown off houses

11 Storm
102–120 km/h
Widespread damage

myWorld Atlas Deepen your understanding of this topic with related case studies and questions. **Wind and sun direction**

ACTIVITIES

INVESTIGATE

1 What ***change*** does difference in air pressure cause?
2 Describe two methods you could use to determine wind speed.
3 In your opinion, which of these methods gives the most useful information about wind speed? Give reasons for your answer.

EXPLAIN

4 Using figure 1, describe the wind speeds and directions in Western Australia and along the east coast of Australia on that day.

PREDICT

5 Collect a weather map from the newspaper or online. Based on what you know about weather and reading synoptic charts predict what the wind conditions will be like in each of the Australian capital cities over the next day or so.
Use the **Wind rose maps** weblink in the Resources tab to compare your predictions with what is shown on these maps. Make sure you select the current month. Note any similarities and differences. Why might differences occur?

APPLY

6 Devise your own symbols similar to those shown in figure 1b. Obtain a current weather map from the newspaper or online. Paste it onto a sheet of paper and annotate your map with your symbols for describing wind speed. Swap maps with a partner and further annotate each other's maps with written descriptions of the symbols shown.

eBook*plus*
Weblink
Wind rose maps

12.14 Review

12.14.1 Review

1. What is a natural resource?
2. What is the difference between a renewable and a non-renewable resource?
3. Using images, recreate figure 2 from subtopic 12.2 'What is a resource?'.
4. Explain how water can be both a renewable and a finite resource.
5. Describe how groundwater is an important source of water globally.
6. List all the ways in which groundwater is important to people. Give examples where possible.
7. Describe how water flows through different parts of the catchment.
8. Use a diagram to describe and explain the water cycle. How does this reinforce that water is a finite but renewable resource?
9. Outline three fieldwork techniques to investigate the quality of water.
10. China has 22 per cent of the world's population but only seven per cent of all freshwater run-off. Use this fact to outline the problem of population pressure on water supplies.
11. What is the difference between weather and climate? Write a jingle or rap to help you remember the difference.
12. Describe in broad terms the type of climate enjoyed by each of Australia's capital cities.
13. Describe what you think the weather might have been like at the following times. Give reasons for your answer in each case.
    a. Sydney on 23 September 2009
    b. Brisbane on 11 January 2011
14. Refer to the map of Australia's climate zones shown in subtopic 12.9, figure 3. Decide, for each of your answers to question 13, whether what you have written is typical of the climate of each of these ***places***. Justify your decision in each case.
15. List and describe the factors that affect water availability globally.

12.14.2 Reflect

16. Study the data in table 1.

TABLE 1 Countries depending on river inflow from other countries for more than half their renewable water

Country	Renewable water supplies originating outside border (%)	Years required for population to double at current rate
Egypt	97	30.1
Netherlands	89	138.6
Cambodia	82	27.7
Syria	79	18.2
Sudan	77	22.4
Iraq	66	18.7

    a. Draw a bar graph to show this data. Refer to the SkillBuilder 'Creating a simple column or bar graph' in subtopic 15.6 to help you.
    b. Use an atlas to locate these countries. In each case, name the river that flows through this and other countries. Name the other countries that also share this river water.
    c. Explain how this situation could cause conflict.
    d. Make predictions for each country in terms of population growth and water supply.



Traditional methods are used to fish sustainably.

CHAPTER 13

Water resources and the water cycle

13.1 Overview

13.1.1 Introduction

Water is an important resource used by people. It has great economic, cultural, spiritual and aesthetic value. The health and wellbeing of a community can be greatly impacted by its access to water, and water can be central to the beliefs and practices of indigenous cultures. Access to water is a basic human right. The amount of available fresh water on Earth needs to be shared among an ever-growing global population. It is a resource that must be used carefully so that current and future populations can have adequate supplies.

Starter questions

1. List some of the different ways water is used in our lives.
2. How would your life be different if you didn't have easy access to water?
3. Do you value water? What are the different ways in which water can have a value to you?
4. Watch the video using the **Introduction to water** weblink in your eBookPLUS. List all the ways that water is used by people, animals, plants and the environment. How much of the Earth is covered by water? How much of this water can be used by people?

eBookplus

Weblink
Introduction to water

Inquiry sequence

		Syllabus outcomes
13.1 Overview		
13.2 How is water used by people?		GE4-2, GE4-3, GE4-7, GE4-8
13.3 SkillBuilder: Drawing a line graph	eBookplus ONLINE ONLY	GE4-7, GE4-8
13.4 What is the value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.5 SkillBuilder: Annotating a photograph	eBookplus ONLINE ONLY	GE4-7, GE4-8
13.6 What is the economic value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.7 How does access to water improve health?		GE4-2, GE4-3, GE4-7, GE4-8
13.8 What is the cultural and spiritual value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.9 How do Indigenous people use water?		GE4-2, GE4-3, GE4-5, GE4-7
13.10 How is water significant to indigenous people?		GE4-2, GE4-3, GE4-5, GE4-7
13.11 What is the aesthetic and social value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.12 What is virtual water?		GE4-2, GE4-3, GE4-5, GE4-7
13.13 Investigating topographic maps: How is water valued in Noosa?		GE4-2, GE4-3, GE4-5, GE4-7
13.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Water: a vital resource
Searchlight ID: eles-1615

13.2 How is water used by people?

13.2.1 Who uses the most water?

There are three main uses made of water by all people: growing food, producing goods and electricity, and using it in the home. The amount of water consumed for each of these uses differs from one place to another. The problem remains that while the total amount of fresh water is fixed, the amount used per person is increasing.

It is interesting to look at water consumption on a global scale. With the global average at 1240 cubic metres per person, per year, some countries consume more water than others. Examples of countries that consume nearly twice as much as the global average are the United States and Thailand. Some countries that consume the least amount of water per person are Peru, Somalia and China.

13.2.2 What is water used for?

Figure 1 shows that most of the world's water is used in agriculture, to grow food for the world's increasing population. This is especially the case in the drier parts of the world where there is not enough rainfall to grow crops or grass for animals. There is a strong interconnection between the amount of rainfall in a region and the amount of water used in agriculture.

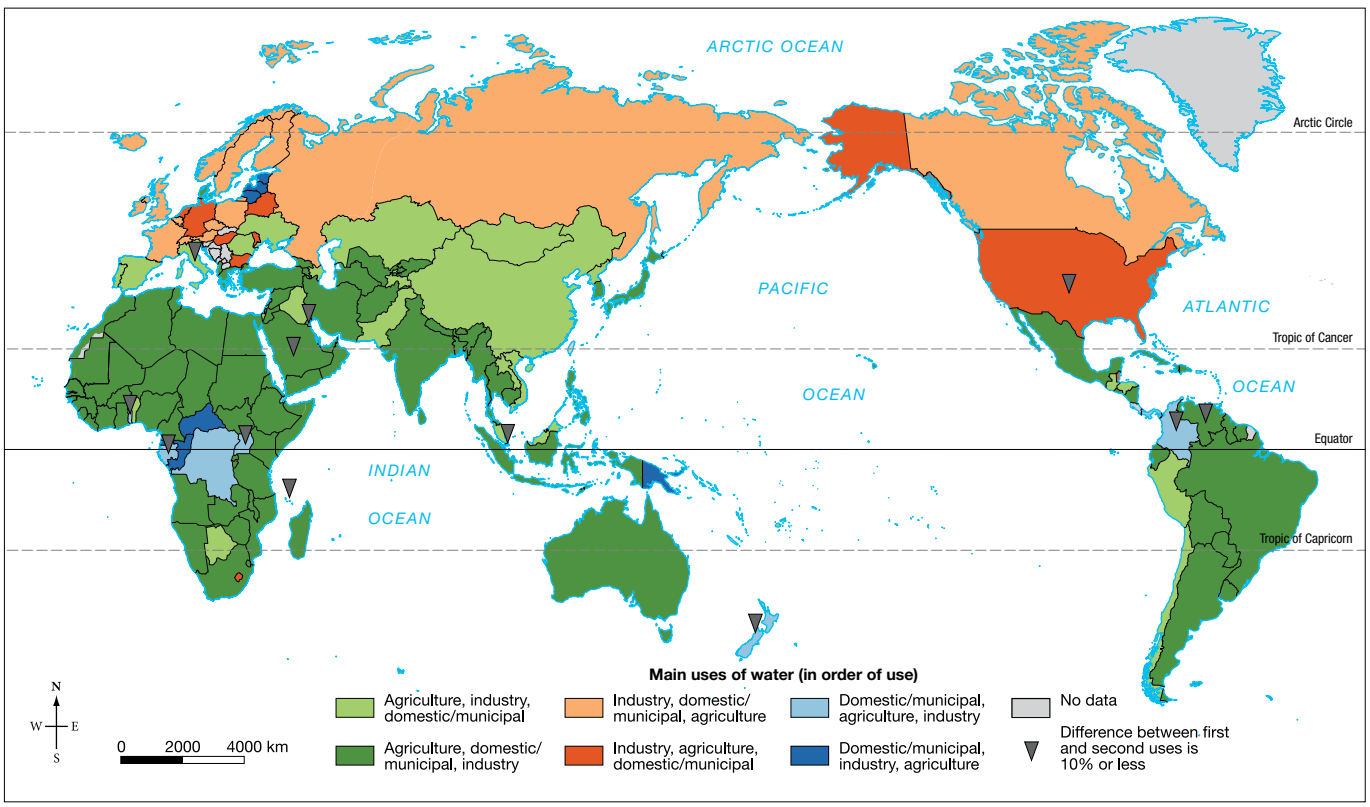
It is interesting to see how this pattern varies in different countries. In some countries, the water used in agriculture and industry is greater than the amount of water used in homes for domestic use. In other places, people consume more water for domestic use than for either agriculture or industry.

13.2.3 How is water used in Australia?

Agriculture is an important industry in Australia, and it is our thirstiest industry. It produces most of our food requirements and contributes enormously to Australia's export earnings.

Around 70 per cent of Australia's fresh water is used as irrigation for farming. Many crops are grown in dry areas where up to half the available water evaporates from the soil surface or seeps down too low into the ground for plant roots to reach it. Therefore, more water is applied than is actually needed by plants. In manufacturing industries, most water is used to produce food, beverages and paper.

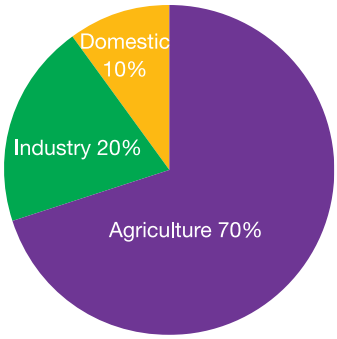
FIGURE 1 Countries in the world differ in their use of water.



Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› How is water used in Australia?
› North-west Europe

FIGURE 2 World water use



In many areas in Australia where rainfall is limited or highly seasonal, farmers irrigate their crops with water stored in dams, with groundwater or with water from major rivers. Irrigation is a very important use of water in Australia. Most large-scale farming could not provide food for Australia's population without using water from rivers, lakes, reservoirs and wells.

There is high demand for irrigation water during summer when river flows are low, and low demand for irrigation water during winter when river flows are high. This reverses the natural pattern of river flow.

TABLE 1 Fresh water use in Australia

Types of use of fresh water	%
Agriculture • (pasture 35%) • (crops 27%) • (rural and domestic stock 8%)	70
Urban	12
Horticulture	10
Industry	3
Mining	2
Services	2
Hydro-electricity	1

TABLE 2 Fresh water used to irrigate different crops in Australia

Crop type	Water (gigalitres)	%
Livestock, pasture, grains and other agriculture	8795	56
Cotton	1841	12
Rice	1643	11
Sugar	1236	8
Fruit	704	5
Grapes	649	4
Vegetables	635	4

Note: One gigalitre = 1 000 000 000 litres or one thousand million litres or 400 Olympic-sized swimming pools

FIGURE 3 Australia is one of the most irrigated countries in the world.



ACTIVITIES

IDENTIFY

1 What is most of the world's water used for?

EXPLAIN

2 Why might some countries use more water in industry than in agriculture or domestic use?

3 Use the data in tables 1 and 2 to draw two line graphs. Use the data from your graphs to describe how water is used in Australia. Which crops use the most water? Which use the least?

INVESTIGATE

4 Watch the video about three rivers in Africa and look at the information on these rivers in *myWorld Atlas*. Use the atlas map to trace the flow of the river and upload images to the map showing all the different water uses in the video.

5 Study figure 1 and decide which of the following statements are true and which are false.

- **a** Australia uses most water for agriculture, then industry, then domestic/municipal.
- **b** Countries in North Africa use most water for industry, then domestic/municipal, then agriculture. (Refer to the 'Regions' resource in your eBookPLUS.)
- **c** Belarus uses most water for industry, then agriculture, then domestic/municipal.
- **d** Colombia uses most water for agriculture, then domestic/municipal, then industry.
- **e** Belize uses most water for industry, then agriculture, then domestic/municipal.
- **f** Malaysia uses most water for industry, then agriculture, then domestic/municipal.

Rewrite the statements that are false and make them true.

APPLY

6 Now use your atlas to look at patterns in figure 1 and compare them to a map that shows global wealth.

- **a** Name a country with low wealth and high water use in industry.
- **b** Name two wealthy countries that do not have high water use in industry.
- **c** Can you write a general statement about wealth and water use? Add two exceptions to your general statement.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Three rivers in Africa

GEOskills TOOLBOX

Drawing a line graph

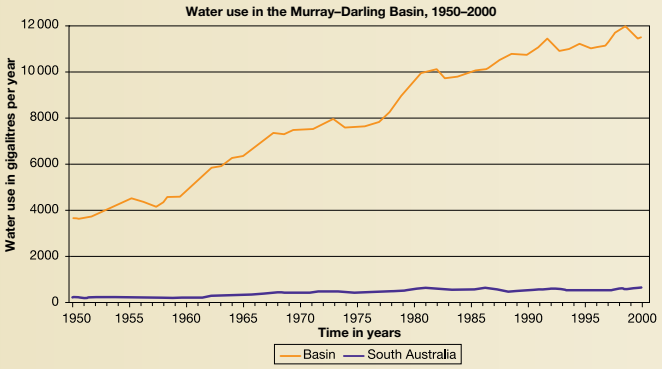
Line graphs represent data as points drawn on a graph and joined together with a line. Often line graphs are used to show change over a period of time. Examine SkillBuilder 13.3 'Drawing a line graph' in your eBookPLUS to learn more about how to draw a line graph.

eBookplus ONLINE ONLY

13.3 SkillBuilder: Drawing a line graph

What is a line graph?

A line graph displays information as a series of points on a graph that are joined to form a line. Line graphs are very useful to show change over time. They can show a single set of data, or they can show multiple sets which enables us to compare similarities and differences between two sets of data at a glance.



eLesson

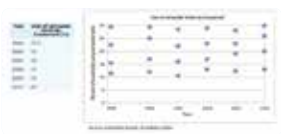
Watch this video to learn how to draw a line graph.



Searchlight ID: eles-1635

Interactivity

Try this interactivity to learn how to draw a line graph.



Searchlight ID: int-3131

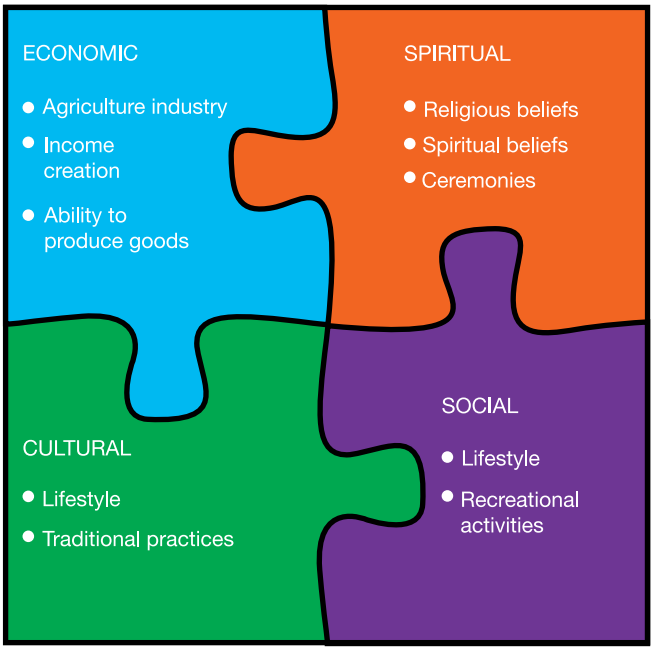
myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Mediterranean basin

13.4 What is the value of water?

13.4.1 How does water quality change?

Value refers to how important something is or what it is considered to be worth. The value people place on water will vary according to their standard of living, income, culture, location and the way they use water. In this way the value of water is subjective. This means that people have different opinions or perspectives. People who live in cities in developed countries with easy access to piped water may not value water as much as farmers in rural areas in the same country. Those living in developing countries with no or limited access to water are likely to feel that water has a much higher value.

FIGURE 1 The different values of water



The value of water and the way that it can be used is determined by the quality of the water.

Different pollutants — faeces (human and animal), food wastes, pesticides, chemicals and heavy metals — can come from industrial wastewater, domestic sewage, cars, gardens, farmland, mining sites and roads, and flow into waterways.

Some countries, cities and local areas are better than others at providing services and enforcing laws to prevent pollutants from entering water. Some of the worst polluted rivers and lakes in the world include rivers and **aquifers** in China (such as the Songhua River and the Yellow River), the Citarum River in Indonesia, the Yamuna and Ganges rivers in India, the Buriganga River in Bangladesh and the Marilao River in the Philippines.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater. Water can move along an aquifer.

13.4.2 How clean is your river?

FOCUS ON FIELDWORK

Fieldwork investigating waterways

Some schools are located close to a waterway, even if it is a highly modified one like a concrete drain. Conducting fieldwork at a local waterway will help you to better understand national and global issues.

The aim is to investigate the physical properties of a river or creek at various points along its length, and to make observations of the water quality and any evidence of human impact. Does the quality of the water change between upstream and downstream sites? Are there human factors that can account for these changes? Differences may be more obvious if the waterway passes through a built-up area or a farm.

The following activities should be undertaken at each site and recorded on paper or directly onto a database on a laptop computer or other mobile device. Use a map and camera to record observations about the surroundings of each site, especially the amount of vegetation and possible human impact. Use GPS to record and map your location at each site.

Temperature

Aquatic plants and animals have a particular temperature range in which they can survive. High water temperatures can result in reduced oxygen available for plants and animals. It is useful to compare temperature readings with biodiversity counts to investigate this relationship. Place the bulb of a thermometer in the water for five minutes and record the result.

pH

We use pH to measure the acidity or alkalinity of water on a scale of 1 to 10. Drinking water should have a pH reading of around 6. A reading either side of this may indicate that water is polluted. You can test pH by taking a sample of water and using pH paper or chemical reagents.

(*continued*)

FIGURE 2 The Citarum River in Indonesia is one of the most polluted rivers in the world.



FIGURE 3 You can create a simple Secchi disc and use it to measure turbidity.

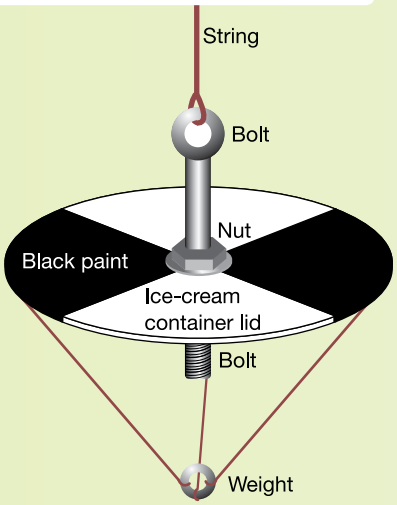


FIGURE 4 Students measuring river water quality



Turbidity

Water that lets little sunlight through is said to be turbid. Turbidity is the amount of suspended sediment in water — sediments such as clay, silt, industrial waste or sewage.

A Secchi disc (see figure 3) is used to measure turbidity. This can be made using an ice-cream lid, string, a weight and black paint.

Lower the disk into the water, making sure there are no waves or ripples, cloud or glare. Do not wear sunglasses when making the reading. When it is only just visible, record the depth in centimetres. The lower the number, the greater the turbidity.

Salinity

Salinity measures the amount of salt in the water. To measure salinity, you will need to use an electrical conductivity meter, or EC meter, which can be bought from science equipment suppliers. Place the meter into the water and take a reading off the screen.

GEOSkills TOOLBOX

Annotating a photograph

Photographs can provide an accurate representation of an area you are studying. By adding annotations, or labels, additional information can be recorded that draws attention to particular features of the photo. Examine SkillBuilder 13.5 'Annotating a photograph' in your eBookPLUS.

1. Take a photo of the field site you visited. Import it into a Word document.
2. Use text boxes and arrows to annotate your photograph showing where you undertook your testing and the results for pH, salinity, turbidity and temperature at each location.

FIGURE 5 Student investigating river water



ACTIVITIES

IDENTIFY

1 How do rivers become polluted?
2 What is an aquifer?

EXPLAIN

3 You will need to organise and present the information you collected in a field report. This can be presented in Google Maps, or as a Prezi presentation, web page or multimedia report. Determine some headings for your report such as a main title; introduction and background; data and findings; and conclusion. Arrange your data and choose the best way to represent it, whether in the form of graphs, tables, two maps, overlays, or photo displays and diagrams. Write an analysis of your data by describing it in detail. Draw conclusions and provide an evaluation of the field trip.
4 You should alert your local council to your findings by inviting someone to a presentation or sending a link to your findings to an appropriate representative. Is there action that needs to be taken to improve this waterway?

INVESTIGATE

5 Work in groups to investigate one of the other polluted rivers mentioned in the text. Show where it is located on a map. What does it look like? What has caused the pollution? Is anything being done to improve conditions?

eBookplus ONLINE ONLY

13.5 SkillBuilder: Annotating a photograph

Using annotated photographs in geography

Photographs are used to show aspects of a place. Annotations are added to photographs to draw the reader's attention to what can be seen and deduced.



eLesson

Watch this video to learn how to annotate a photograph.



Searchlight ID: eles-1633

Interactivity

Try this interactivity to learn how to annotate a photograph.



Searchlight ID: int-3129

13.6 What is the economic value of water?

13.6.1 Rice farming and aquaculture in Asia

The **economic** value of water must include all the different ways that we use water to produce a good or service. This includes drinking water, water used for irrigation, water used for **industry** and in recreation, and power generation. It can also relate to the importance of water as a breeding ground and nursery for fish stocks. In Australia and many other countries, the basic

economic a system made up of producing, buying and selling goods and services

industry the production of goods and services

economic value of water is recognised in the charges we pay to access piped water. Water plays a significant role in the production of food through the agricultural industry. It can contribute to domestic food security and the reduction of poverty.

In Asia, rice forms the main staple food for the majority of the population. The world's top five rice producers in 2014 were all found in Asia — China, India, Indonesia, Vietnam and Thailand. Rice cultivation is best suited to areas with a tropical climate, with warm temperatures and high amounts of rainfall. Rice production requires a high amount of water availability. Rice is an important form of foreign income particularly in Thailand, India and Vietnam.



FIGURE 1 Terraced rice fields



FIGURE 2 A Vietnamese farmer in a rice field

Aquaculture, also known as aqua farming, involves breeding and harvesting plants and fish in water environments. It can include farms in both salt water and fresh water. The aqua farms are set up in ponds, cages, on rafts and long lines (for shellfish).

Overfishing, destructive fishing practices and pollution have taken a toll on fish populations in the wild. As wild fish populations have plunged, fish catches by traditional means have declined, and aquaculture is a way of addressing this shortage. Aquaculture contributes to world fish supplies and food security in Asia.

FIGURE 3 An aquaculture worker feeding fish



Aquaculture is heavily concentrated in Asia, in areas where there are tropical climates, vast coastlines and large inland water bodies. These features can make many Asian countries suitable for aquaculture industries.

Aquaculture is an important source of foreign income and an important factor in encouraging economic development. Aquaculture can support local communities by generating employment and income, and provides a means to significantly improve standards of living. Often, traditional aquaculture operations tend to be small-scale and farmer owned and managed, providing autonomy to the owner. Aquaculture can often complement other farming practices such as rice farming, and a rice–fish culture has developed in some regions of China and India. Aquaculture provides opportunities for participation of both the men and women of the community. Much of the daily management and often the sale of the products is carried out by women.

Despite the economic benefits of aquaculture, it also has a number of environmental impacts. These include natural habitat destruction, release of chemical and organic effluent, and the depletion of wild fish stocks.

ACTIVITIES

IDENTIFY

1 Outline the importance of water as an economic resource.

EXPLAIN

2 Explain how important water is for rice production in Asia.

3 Explain the importance of fish farming and aquaculture in South-East Asia.

INVESTIGATE

4 Use the internet to research the environmental impacts of aquaculture such as natural habitat destruction, release of chemical and organic effluent, and the depletion of wild fish stocks. Share your findings with your class.

13.7 How does access to water improve health?

13.7.1 How does dirty water affect health?

Water has great value in improving the health and living standards of people around the world.

Nearly 900 million people in the world have no access to clean water, and 2.6 billion people have no safe way of disposing of human waste. Lack of toilets means many people defecate in open spaces or near the same rivers from which they drink. It is estimated that 90 per cent of sewage in poor countries ends up flowing straight into rivers and creeks.

This is an unacceptable situation. Dirty water and lack of proper hygiene kill 3.3 million people around the world every year, most of them children younger than five. People who are sick are often unable to work properly, to look after their families or to attend school, adding to the poverty cycle they may already be in. The diseases that can be passed on to people as a result of contaminated water include diarrhoeal diseases such as cholera, typhoid and dysentery. Malaria, a disease transmitted by mosquitoes, kills about a million people every year.

13.7.2 How can water-borne diseases be reduced?

People use different methods to treat the water they have collected. They can let it stand and settle, strain it through a cloth, filter it, add bleach or chlorine, or boil it. Some people do not treat their water at all.

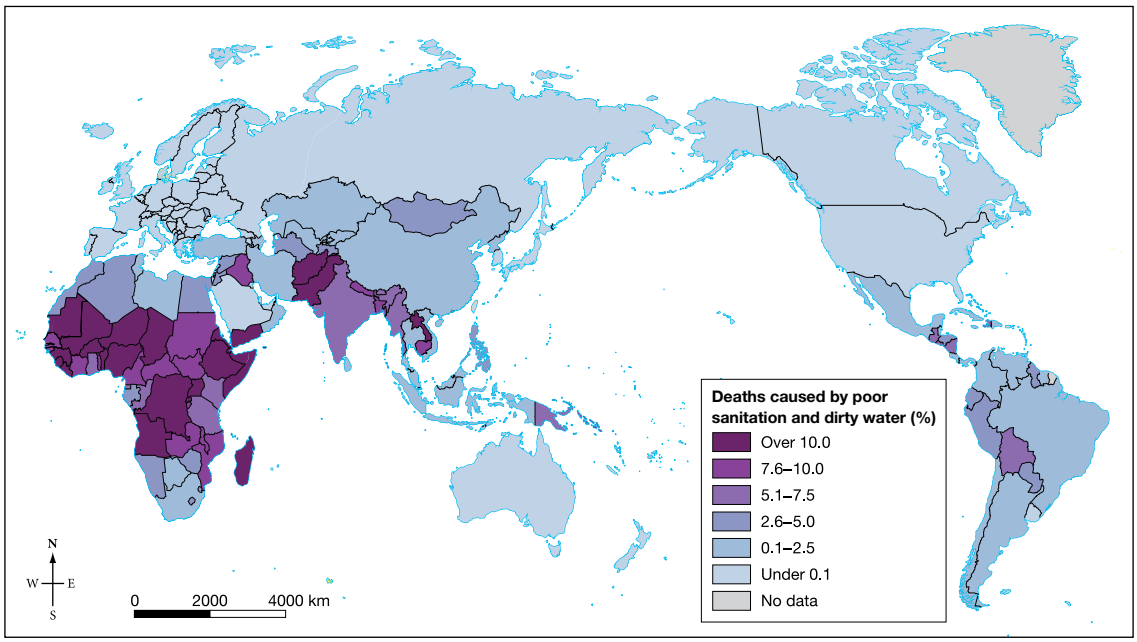
When there is barely enough water to drink or to cook with, it is difficult for people to set aside water for washing hands and cleaning clothes. However, hygiene and sanitation are very important for health.

A number of aid groups, such as WaterAid, Water.org, CARE and A Glimmer of Hope, work on projects to improve sanitation and access to clean water. Washing hands, building cheap and effective toilets and teaching the community about good hygiene all help to reduce disease.

13.7.3 Millennium Development Goals

In 2000, the United Nations agreed on eight Millennium Development Goals (MDGs) to combat global poverty. Each MDG had measurable targets, and the UN aimed to reach them by 2015. Water and sanitation came under goal 7, target 3: it aimed to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.

FIGURE 1 Deaths caused by poor sanitation and dirty water



Source: Spatial Vision



FIGURE 2 Collecting water that is unsafe to drink

Data from **UNICEF** and the World Health Organization show that the water target was reached in 2010, when 1.8 million more people had access to safe water than in 1990. There are still 780 million people who need access to improved drinking water but, as of 2015, 91 per cent of the world's people have improved drinking water.

The water target is progressing better than the sanitation target. In 2015, 1 in 3 of the world's population lived without access to improved sanitation. The vast majority live in Asia and sub-Saharan Africa. At current rates the sanitation target of 75 per cent will be missed.

The maps in figures 4 and 5 show there are regional patterns to success or failure of these targets, particularly in large parts of Africa.

The Sustainable Development Goals have replaced the Millenium Development Goals. Goal 6 is based on clean water and sanitation.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › World health

CASE STUDY

Community-led total sanitation (CLTS), Nigeria

WaterAid went to a village called Olorioko in the state of Ekiti to see if they could improve the sanitation. When they arrived, there were very high rates of illness and death due to water-related diseases. The people in the village used the bush near their houses as their toilet.

CLTS leaders developed a relationship with the villagers and taught them how faeces can enter their food and make them sick. Once this was understood, the people wanted to change their practices so this would no longer happen. Action plans were drawn up and eventually the villagers created clean water points, built simple but effective toilets, and were given lessons in sanitation.

The health of the entire village has improved and they are also increasing their wealth. The CLTS project, which started in Bangladesh some years ago, has been a success and is spreading throughout Nigeria.

Use the **Health is wealth** weblink in your eBookPLUS to learn about a community-led sanitation project.

FIGURE 3 Location of Nigeria in Africa



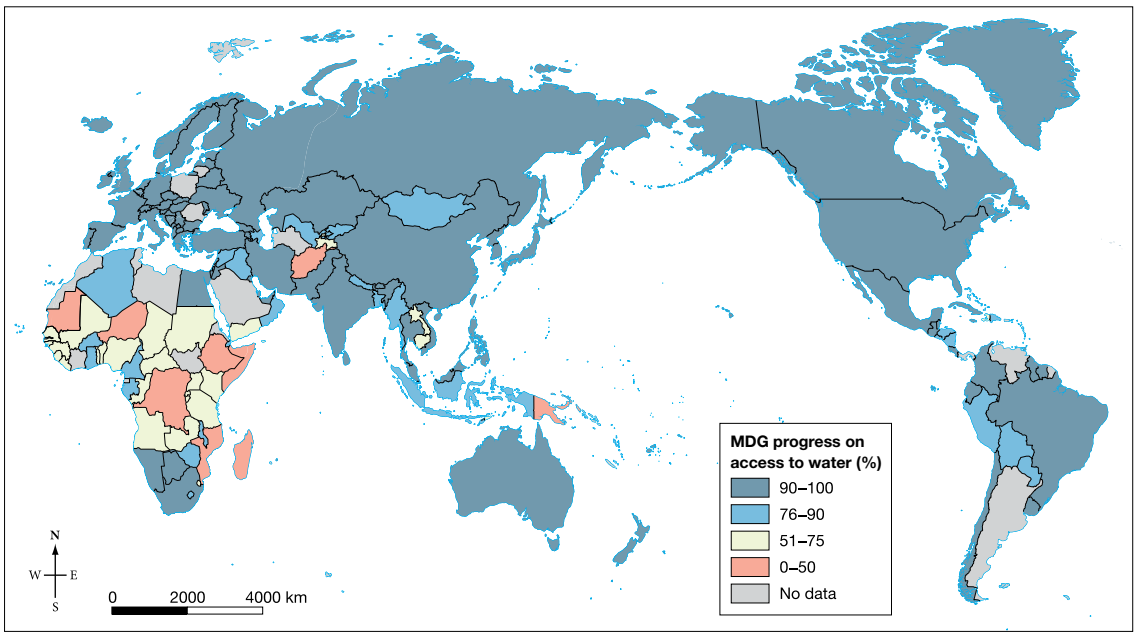
Source: Spatial Vision

UNICEF United Nations Children's Fund: a UN program that provides humanitarian and developmental assistance to children and mothers in developing countries

eBookplus

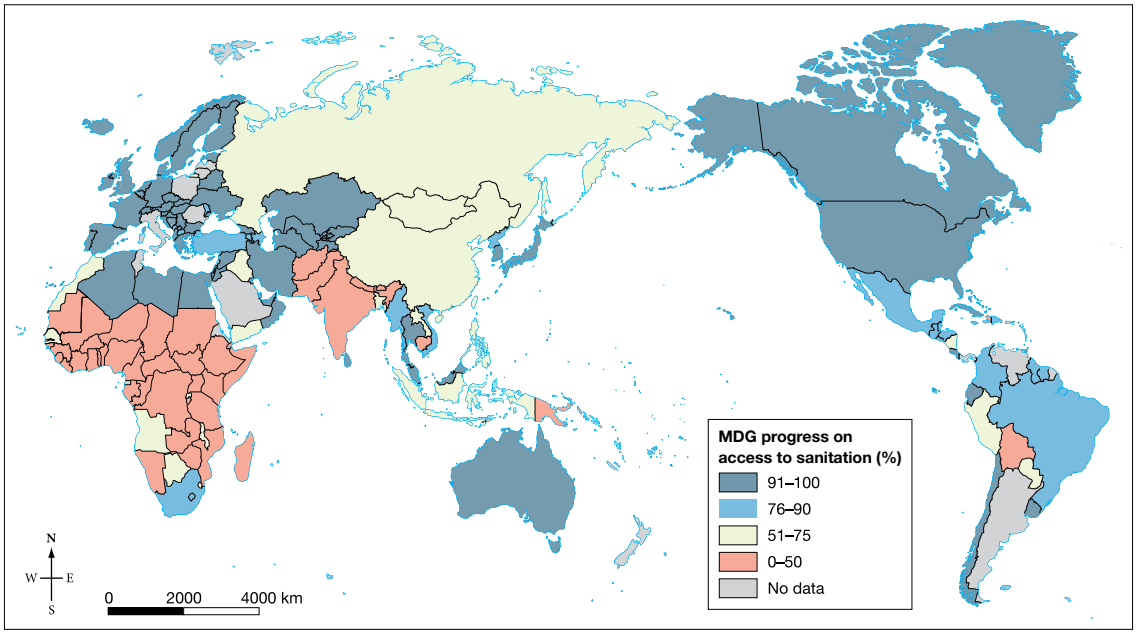
Weblink
Health is wealth

FIGURE 4 MDG progress on access to water



Source: Spatial Vision

FIGURE 5 MDG progress on access to sanitation



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 How many people in the world do not have access to clean water or sanitation?
2 Describe Nigeria's location in Africa and in relation to other countries and ***places***.
3 What does CLTS stand for?

EXPLAIN

4 Study figure 1. Look at sub-Saharan and North Africa. (See the 'Regions' resource in your eBookPLUS.)
   a Name three coastal and two landlocked countries in these regions.
   b How many countries in this region suffer deaths caused by poor sanitation and dirty water?
   c Name the continents and regions that have the fewest deaths.
   d Why do you think this *spatial* pattern exists? (*Hint:* look at maps in your atlas that show wealth.)
5 Explain what the community-led total sanitation project aims to do.
6 Use the information in the maps to explain how the MDGs are being achieved for water and sanitation. Explain this for each world region. Use the **WHO/UNICEF** weblink in your eBookPLUS to see an interactive world map showing specific figures for water and sanitation.

PREDICT

7 What might happen to people's health in North and sub-Saharan Africa if access to water and sanitation is not improved?
8 A number of aid agencies are working in countries and regions to improve access to sanitation and clean water. Choose one of those listed in this chapter and find out more about what they are doing. How will their work make a difference to the living conditions of the people they are helping?

APPLY

9 Work in groups of three or four. Use the data and facts in these pages to plan a day of promoting knowledge about this issue at your school. Make particular reference to North and sub-Saharan Africa, and find out what is being done by aid organisations to improve the situation in these regions. Plan a video presentation that is interesting and catchy and will help people understand the action needed to improve access to clean water and sanitation. Use video and video editing programs and internet research in your planning.

eBook*plus*

Weblink
WHO/UNICEF

13.8 What is the cultural and spiritual value of water?

13.8.1 The importance of water

In some communities water is central to the livelihoods and cultural practices of their people. Water is integral to some sacred landscapes for Aboriginal and Torres Strait Islanders, and as a result these locations have significant spiritual value.

CASE STUDY

Stories help map the location of water

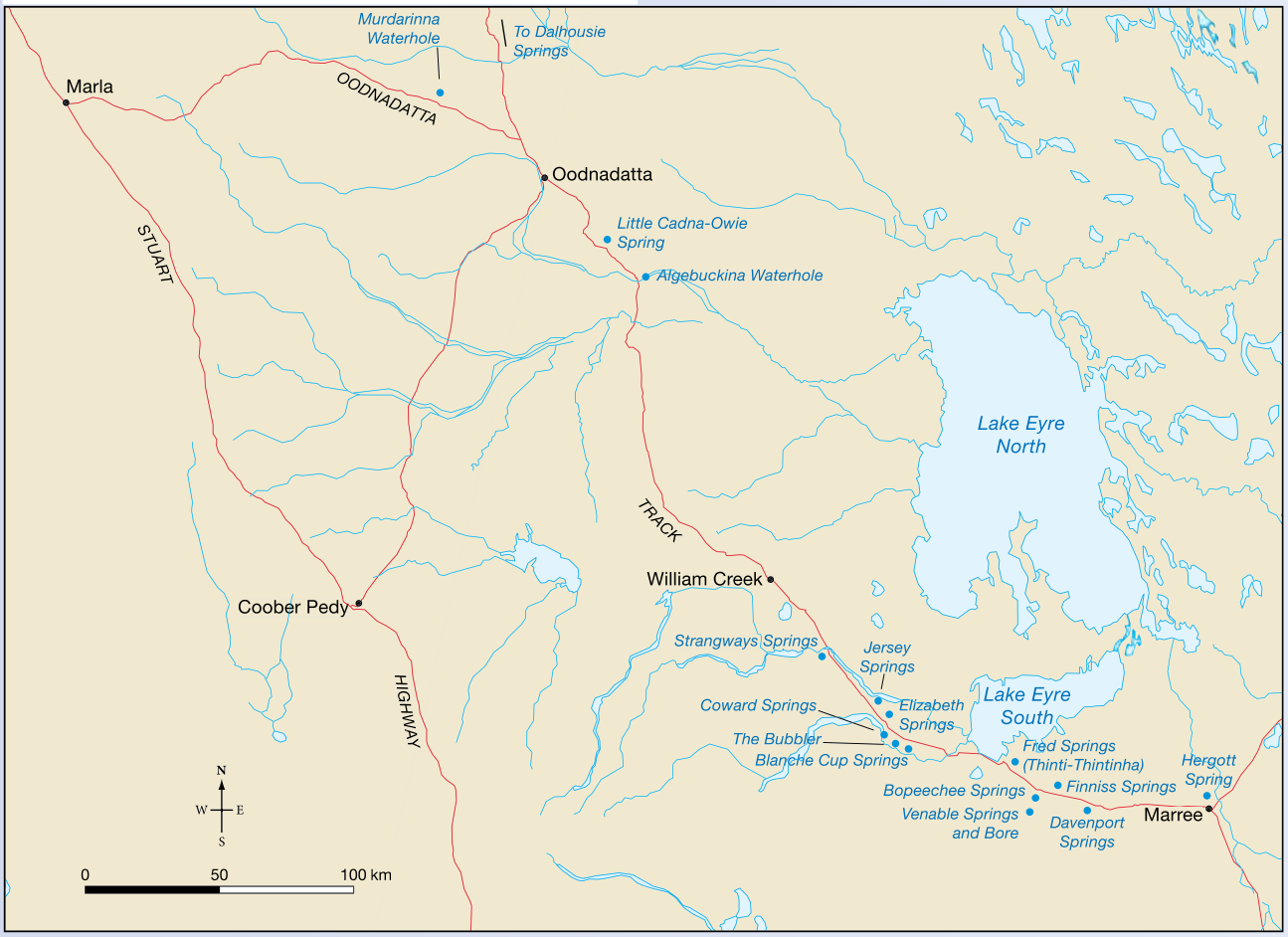
Australian Aboriginal knowledge of the land and how to survive in it has been passed from generation to generation through **Dreaming** Stories. During the dry seasons and periods of drought, Aboriginal people congregated at the mound springs. These springs were linked by traditional Aboriginal song and story lines, and are often connected to rain-making rituals.

Dreamtime stories

1 Thutirla Pula (Two Boys Dreaming)

This is one of the most important stories of the Wangkangurru and other people of Central Australia. Thutirla Pula is how the spirits of The Dreaming first crossed the desert they call Munga-Thirri (land of sandhills). One of the most important songlines is the story of the Two Boys Dreaming. The story tells of two boys crossing the Simpson Desert, through Queensland and back to just north of Witjira (Dalhousie) in the Finke River area. The songline contains information on every waterhole or soak that was known in the Simpson Desert. Following this songline meant you could cross the Simpson Desert using available groundwater along the way, taking 600 kilometres off the usual journey south of the Simpson Desert to Lake Eyre, then back north along the Diamantina River.

FIGURE 1 Groundwater springs along the Oodnadatta Track



Source: Spatial Vision

2 Bidalinha (or the Bubbler)

The Kuyani ancestor Kakakutanha followed the trail of the rainbow serpent Kanmari to Bidalinha (or the Bubbler) where he killed it. He then threw away the snake's head, which is represented by Hamilton Hill, and cooked the body in a dirga, or oven, which is now Blanche Cup. Kakakutanha's wife, angry at missing out on the best meat from the snake, cursed her husband, and he went on to meet a gruesome death at Kudna-ngampa (Curdimurka). The bubbling water represents the movements of the dying serpent.

FIGURE 2 The Old Bubbler on the Oodnadatta Track, where the Dreamtime serpent died



3 Thinti-Thintinha Spring (Fred Springs)
The willy wagtail (or thunti-thuntinha) danced his circular dance to create this spring and the surrounding soils, which are easily airborne in windy conditions. The moral to the story is that, while it is easy to catch the skilful little willy wagtail, you must never do so because of the terrible dust storms that may follow.

4 Kewson Hill: the Camp of the Mankarra-kari — the Seven Sisters
The Seven Sisters came down here to dig for bush onions (yalkapakanha). As they peeled the onions, they tossed the skins to one side, creating the dark-coloured extinct mound spring on the south-west side of the track. The peeled bulbs created the light-coloured hill (yalka-parlumarna) to the north-east, also an extinct mound spring.

5 Dalhousie Springs
Dalhousie Springs is a popular oasis in the arid desert region of the northernmost part of South Australia.



FIGURE 3 Fed by the thermal waters of the Great Artesian Basin, the water in Dalhousie Springs is between 34 and 38 °C.

ACTIVITIES

EXPLAIN
1 Why were Dreaming Stories important to Aboriginal people in the Oodnadatta region?

INVESTIGATE
2 Research a community in Asia and explain the cultural or spiritual significance of water to that community.

Dreaming in Aboriginal culture, the time when the Earth took on its present form, and cycles of life and nature began, also known as The Dreamtime. Dreaming Stories pass on important knowledge, laws and beliefs.

13.9 How do Indigenous people use water?

13.9.1 Groundwater sources

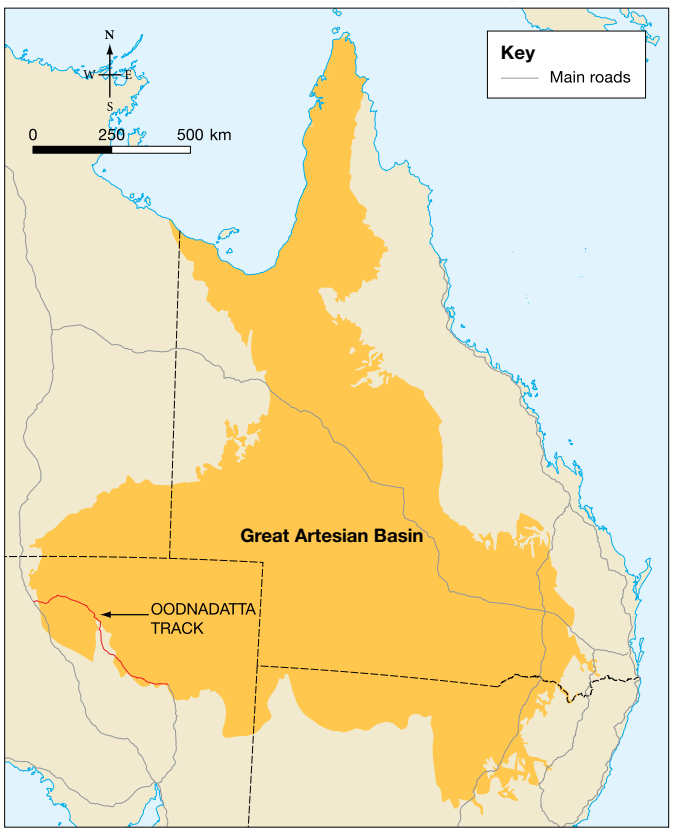
Aboriginal people have lived in the Australian landscape for thousands of years, and they have had the knowledge to survive many changes and challenges. In order to obtain water in the country's dry regions, particularly in Australia's deserts, they have needed to know where to find groundwater.

There are many groundwater sources throughout Australia that have long been used by Aboriginal people. One of these sources is **soaks**: groundwater that comes to the surface, often near rivers and dry creek beds, and which can be identified by certain types of vegetation. Another source is **mound springs**: mounds of built-up minerals and sediments brought up by water discharging from an aquifer.

Mound springs of the Oodnadatta Track

The Oodnadatta Track is located in the north-east of South Australia. The track follows the edge of the Great Artesian Basin and the south-western edge of Lake Eyre and, along its route, groundwater makes its way to the surface in several locations.

FIGURE 1 Location of the Oodnadatta Track and Great Artesian Basin, one of the world's largest groundwater basins



Source: Spatial Vision

FIGURE 2 The Oodnadatta Track passes close to the Old Ghan, the Great Northern Railway.



The Oodnadatta Track crosses the traditional lands of three Aboriginal groups. In the south, between Lake Torrens and Lake Eyre, are the Kuyani people; most of the west of Lake Eyre has been traditionally occupied by the Arabana people; and to the north is the land of the Arrernte people.

Many springs have cultural significance today for local Aboriginal people, whose ancestors relied on the springs as water sources and as sacred sites for important ceremonies. Knowledge of the springs in this region has been passed down over many generations through Dreaming stories.

This knowledge was also passed on to explorers and settlers. John McDouall Stuart followed this track to complete the first crossing of Australia's interior from south to north in 1862; the overland telegraph was constructed along its pathway; and the Great Northern Railway, which made the land of the Northern Territory accessible for white settlement, followed the same route.

soak place where groundwater moves up to the surface

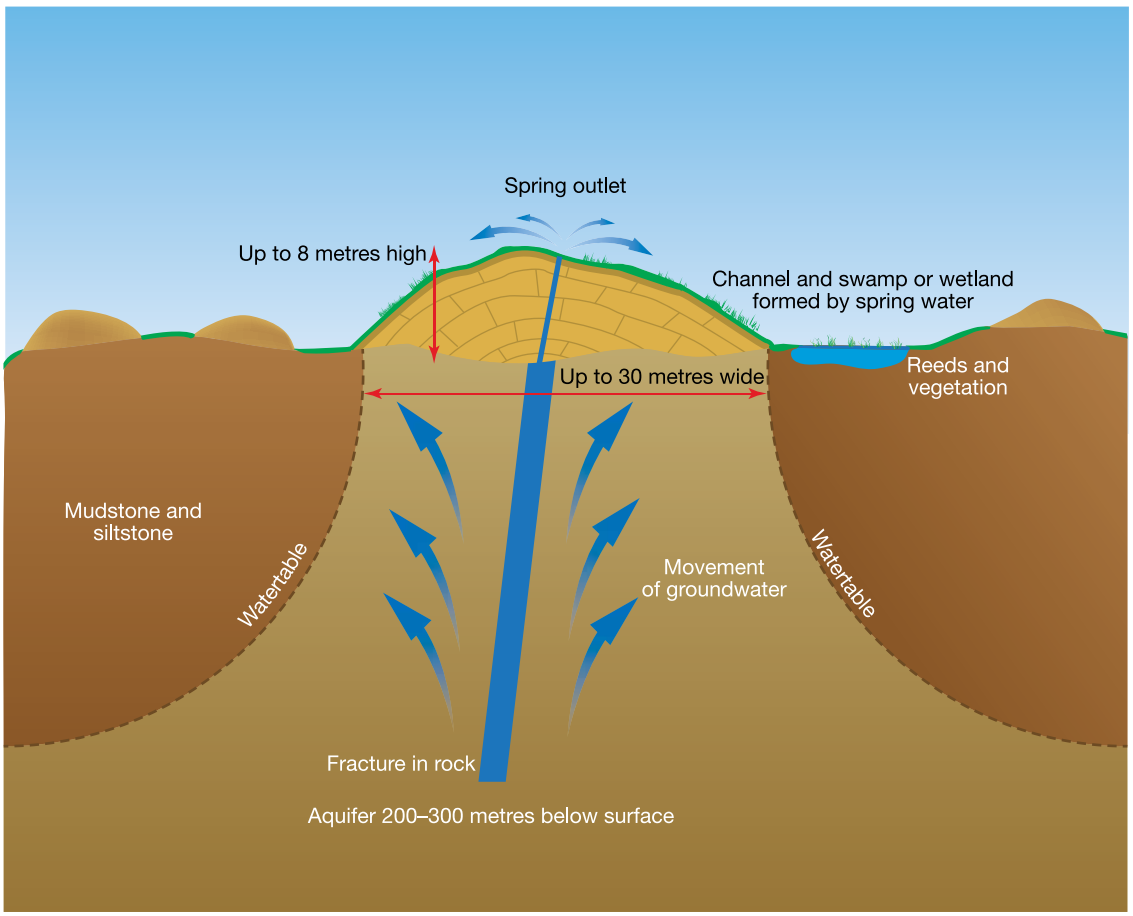
mound spring mound formation with water at its centre, which is formed by minerals and sediments brought up by water from artesian basins

Mound springs were very important for Australian Aboriginal people. They could rely upon springs as reliable sources of water in a very harsh, dry environment.

Old campsites and animal remains provide evidence that they remained there for varying time periods. However, because the plant and animal life around these regions is quite sparse, people had to move regularly and travel away from the springs when rainfall allowed that to occur.

Because the springs were strung out over hundreds of kilometres, they were also part of an important network of trading and communication routes across Australia. As Aboriginal people moved around the region, they traded goods and communicated with other groups. This interconnection between groups allowed them to trade resources such as ochre, stone and wooden tools, bailer shells, and pituri. Pituri is a spindly shrub used by Aboriginal people during ceremonies and to spike waterholes to catch animals for food.

FIGURE 3 Cross-section of a typical mound spring



ACTIVITIES

EXPLAIN

1 Why is groundwater so important to the communities in this region today?
2 How do Dreaming stories help map the groundwater in this region?

INVESTIGATE

3 Use Google Earth and enter the search terms Oodnadatta or William Creek to locate the Oodnadatta Track. Describe the landscape you see. Why is finding groundwater so important in this ***environment***?
4 Use an atlas or Google Earth to locate Dalhousie Springs, Birdsville, Lake Eyre and the Diamantina River. See if you can follow the Two Boys Dreaming story and show how following the story saved a lot of time travelling across the desert.

13.10 How is water significant to indigenous people?

13.10.1 World indigenous cultures

Water is very important to both indigenous and non-indigenous peoples across the world, and is used for many different purposes. Water is important to both groups for different reasons. Water has a spiritual importance to indigenous peoples and they have strong connections with the natural world.

This Indigenous Peoples' Water Declaration shows the importance of water. This declaration came from a meeting in 2008 in north-east Arnhem Land, Northern Territory, where a group of indigenous people from around the world met to discuss water management issues.

> We, the indigenous peoples from all parts of the world assembled here, reaffirm our relationship to Mother Earth and responsibility to future generations to raise our voices in solidarity to speak for the protection of water. We were placed in a sacred manner on this earth, each in our own sacred and traditional lands and territories, to care for all of creation and to care for water.
>
> ***Source:*** www.indigenouswater.org

13.10.2 Aboriginal and Torres Strait Islanders

Depending on where Aboriginal people lived, they traditionally collected surface water from creeks, rivers and waterholes; from underground water supplies such as soaks and springs; or directly from plants, including tree roots.

Recently, evidence collected from oral histories, Dreaming Stories, rock art, artefacts, ceremonial body painting, and historical records left by missionaries, surveyors, settlers and explorers shows that Indigenous Australians managed their water carefully. They channelled and filtered their water, covering it to keep it clean and to stop it from evaporating. They also created wells and tunnel reservoirs.

Aboriginal seasons are closely linked to water. Use the **Miriwoong seasonal calendar** weblink in your eBookPLUS to see an example of one Aboriginal calendar where seasons, water and activities are closely linked.

13.10.3 Water and Aboriginal culture

In a report on the cultural values of water for the Anmatyerre people in the Northern Territory it was stated:

> Our cultural values of water are part of our law, our traditional owner responsibilities, our history and our everyday lives. Everyone and everything is related. Our law has always provided for the values we place on water. It is the rules for men, women and country. Anmatyerre Law is strong today, but it is invisible to other people. Australian law should respect Anmatyerre Law so we can share responsibility for looking after water.

The rainbow serpent is a key symbol of creation, but its journey from underground to the surface also represents groundwater rising to the top via springs. The creation of water sources and where to find them was often told in stories or through artwork. Use the **How the water got to the plains** weblink in your eBookPLUS to hear one story that describes how billabongs appeared in the dry inland plains, told by Butchulla elder Olga Miller.

eBookplus

Interactivity
Thutirla Pula
Use this interactivity to check your understanding of how Indigenous and non-Indigenous Australians have used groundwater resources in the Lake Eyre region.
Searchlight ID: int-3079

Weblinks
- Miriwoong seasonal calendar
- How the water got to the plains

eBookplus

Weblink
Water Dreaming

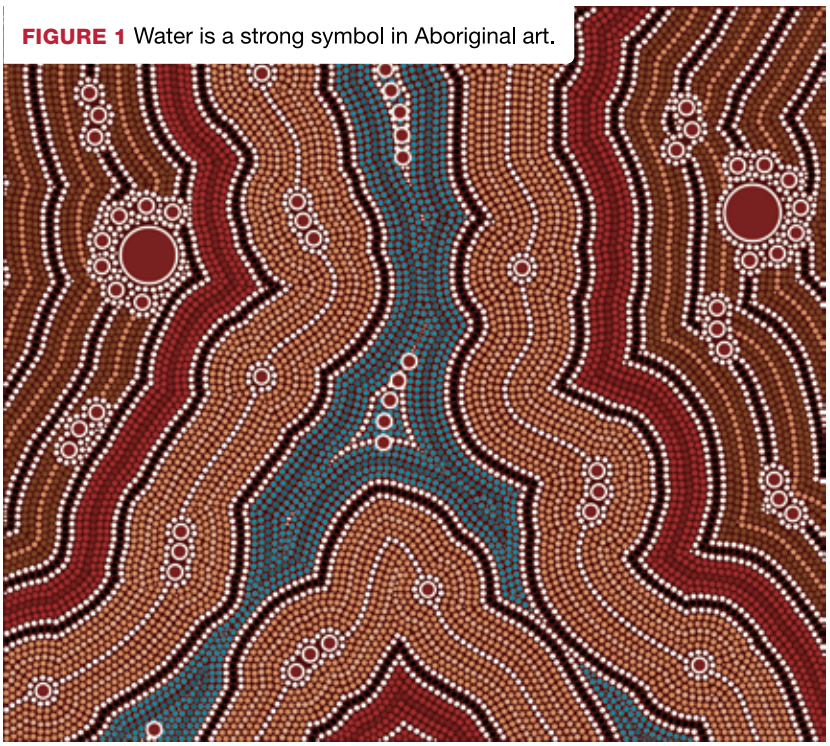


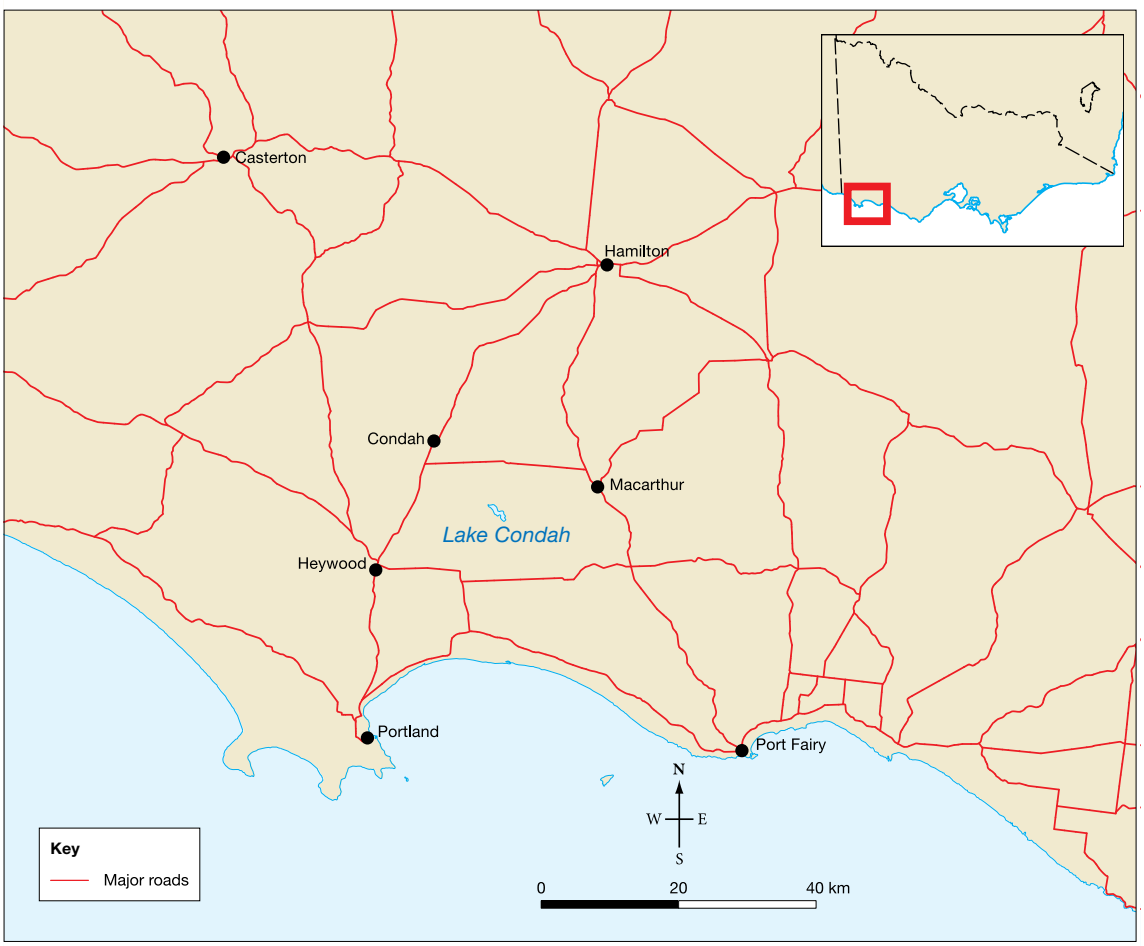
FIGURE 1 Water is a strong symbol in Aboriginal art.

Use the **Water Dreaming** weblink in your eBookPLUS to hear an interview with artist Malcolm Maloney Jagamara.

An Indigenous water project

On 30 March 2008, the Victorian government returned the heritage-listed Lake Condah in Victoria to the Gunditjmara traditional owners. Lake Condah is considered one of Australia's earliest and largest aquaculture ventures. Aquaculture is the growing and harvesting of animals and plants in a water environment. The Gunditjmara people want to preserve their culture while engaging in tourism, water restoration and sustainability projects. One example is the plan to restore the ancient stone aquaculture system at the lake for eel farming.

FIGURE 2 Location map of Lake Condah



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 From what sources did Aboriginal people collect water?
2 Define *aquaculture*.

EXPLAIN

3 What does evidence show about traditional Aboriginal Australians managing water supplies?

INVESTIGATE

4 Use the **Miriwoong seasonal calendar** weblink in your eBookPLUS to learn more about water seasons and food. How is water closely associated with Indigenous activities in this region?
5 Look at the Miriwoong interactive calendar.
  a Which Australian region does this calendar represent?
  b How are the seasons divided? How does this compare with a European calendar?
  c How are seasons and water linked in this calendar?
6 Use Google Earth to locate the Wabma Kadarbu Mound Springs Conservation Park. Place a pin on this location. Now zoom in and out to help you complete the following.
  a Where is this park located in South Australia? Where is this ***place*** in relation to where you live? Use distance and direction in your answer.
  b What is the name of the nearest road?
  c Describe the surrounding area.
  d Why would these springs be so important to Aboriginal people and European explorers?
  e Do some research to find out why these springs are protected today.
  f Use Google Maps to annotate this area with your findings. Include photos that you find using the internet.

APPLY

7 Use the **How the water got to the plains** weblink in your eBookPLUS to listen to the Dreaming Story. How is Aboriginal culture closely associated with ***place*** and ***environment***?

eBook*plus*

Weblinks
- Miriwoong seasonal calendar
- How the water got to the plains

13.11 What is the aesthetic and social value of water?

13.11.1 The value of water

Water can have an aesthetic value. Aesthetics is about to the nature and appreciation of beauty, and can be used to describe the way people respond to the environment. It includes the way people interact with a place through their senses and the emotions they experience.

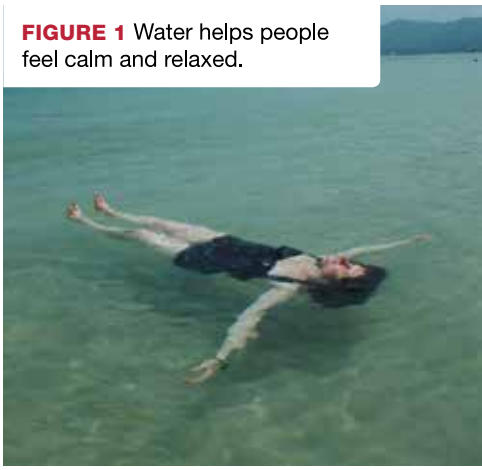


FIGURE 1 Water helps people feel calm and relaxed.

Water contributes to the visual quality of an environment. Houses and units near rivers, lakes and the ocean tend to be much more expensive than properties some distance from the water. In part, this takes into consideration the aesthetic value of a water view. People enjoy being able to watch the waves breaking, or to watch sailboats on a lake from their homes.

Together with vegetation, water is one of the most important features of an environment in providing emotional and psychological benefits to people. Water is required for basic human survival, and environments that contain a large amount of

FIGURE 2 The aesthetic characteristics of water

Water with high aesthetic value	Water with low aesthetic value
Pristine Little odour Clear Transparent Blue or slightly green colour Free from floating debris, scum and oil	Polluted Smelly Murky Opaque Dark green to brown colour Floating debris, scum and oil

CASE STUDY

The aesthetic value of the Great Barrier Reef

When people visit the Great Barrier Reef they feel a sense of beauty, naturalness and remoteness. The amazing contrasting colours of the water ranging from deep, dark blues to iridescent bright aqua contribute to the natural beauty of the reef. The bright white sand, the green islands and the unusual shapes of the reefs and cays create beautiful mosaic patterns in the water.

FIGURE 3 The beauty of living creatures, and vegetation above and below the waters surrounding Fitzroy Island on the Great Barrier Reef in Queensland



water make people feel safe and nurtured. Being close to water and appreciating its beauty can help people feel relaxed and calm.

Water also has a social value as it helps people to undertake activities that help to maintain a healthy lifestyle and social interactions. People are able to undertake many activities such as swimming, kayaking, sailing, and a range of other water sports.

ACTIVITIES

IDENTIFY

1 Define *aesthetics*.

EXPLAIN

2 Why would it be important to have clear water in an area where there are swimming activities?

3 Examine the photographs of Fitzroy Island on the Great Barrier Reef (figure 3). What features can you observe in these photographs that contribute to the aesthetic value of water?

FOCUS ON FIELDWORK

Environmental Perception Form

Visit a local area that has water such as a river, lake or beach. Examine the site and fill in the table below. The aim of this activity is to obtain some qualitative data from your visit. This can be difficult to measure with numbers and there is no absolute, correct answer. Recreate the table below and put a tick in the box which you think best indicates your feelings.

	1	2	3	4	5	
Beautiful						Ugly
Fresh						Smelly
Healthy						Chaotic
Moving						Motionless
Quiet						Noisy
Clean						Dirty
Light						Dark

1 Did the site you visited mainly receive high ratings or low ratings?

2 Describe your fieldwork site in one paragraph. Try to use synonyms (similar words) rather than the words in the Environmental Perception Form.

3 What changes would you suggest be made to this environment to improve its aesthetic value?

4 Explain how changes to this environment could impact on the social and mental wellbeing of local residents and visitors.

13.12 What is virtual water?

13.12.1 Virtual water

The water we consume is not just what we use in cooking, drinking, washing, flushing or in the garden. Water is used to manufacture everything we use: mobile phones, toys, cars and newspapers. This **virtual water** needs to be considered in our water footprint — that is, the water used to produce all our goods and services.

virtual water all the water used to produce goods and services. Food production uses more water than any other production.

Virtual water is also known as embedded water, embodied water, or hidden water. It includes all the water used to produce goods and services. Food production uses more water than any other production.

Hidden in a cup of coffee are 140 litres of water used to grow, produce, package and ship the beans. That is roughly the same amount of water used by an average person daily in Australia for drinking and household needs. There is a lot of water hidden in a hamburger too: 2400 litres. This includes the water needed to grow the feed for the cattle over a number of years, to grow wheat for the bread roll, to grow all the other ingredients in the hamburger, and to process all the food.

Virtual water varies from food to food. For example, it takes about 3400 litres of water to grow one kilogram of rice, whereas it takes 200 litres to grow one kilogram of cabbage. Regions that are water

stressed and that export food and other products (such as Australia and some countries in Africa and Asia) are also effectively exporting their precious water in these goods.

A country that imports rice, rather than growing it locally, therefore saves 3400 litres of water for every kilogram it imports. Some countries (such as Japan) have very little land on which to grow food; other countries have very few cubic metres of renewable water per person. Singapore, for example, has only about 130 cubic metres per person. Both types of countries survive by virtual water imports: they import food rather than attempt to grow and produce all their food themselves. This means that small, wealthy countries can import food that needs a lot of water to produce, and export products that need little water to produce. This makes water available for other domestic purposes such as drinking and cooking.

The major exporters of virtual water are found in North and South America (the United States, Canada, Brazil and Argentina), South Asia (India, Pakistan, Indonesia, Thailand) and Australia. The major virtual water importers are North Africa and the Middle East, Mexico, Europe, Japan and South Korea.

13.12.2 What is a water footprint?

water footprint the total volume of fresh water that is used to produce the goods and services consumed by an individual or country

The **water footprint** of an individual or country is the total volume of fresh water that is used to produce the goods and services consumed by the individual or country. It includes the use of:

- blue water (rivers, lakes, aquifers)
- green water (rainfall used for crop growth)
- grey water (water polluted after agricultural, industrial and household use).

Not all goods consumed in one particular country are produced in that country — some foods and products are imported. Therefore the water footprint consists of two parts: use of domestic water resources and use of water outside the borders of the country.

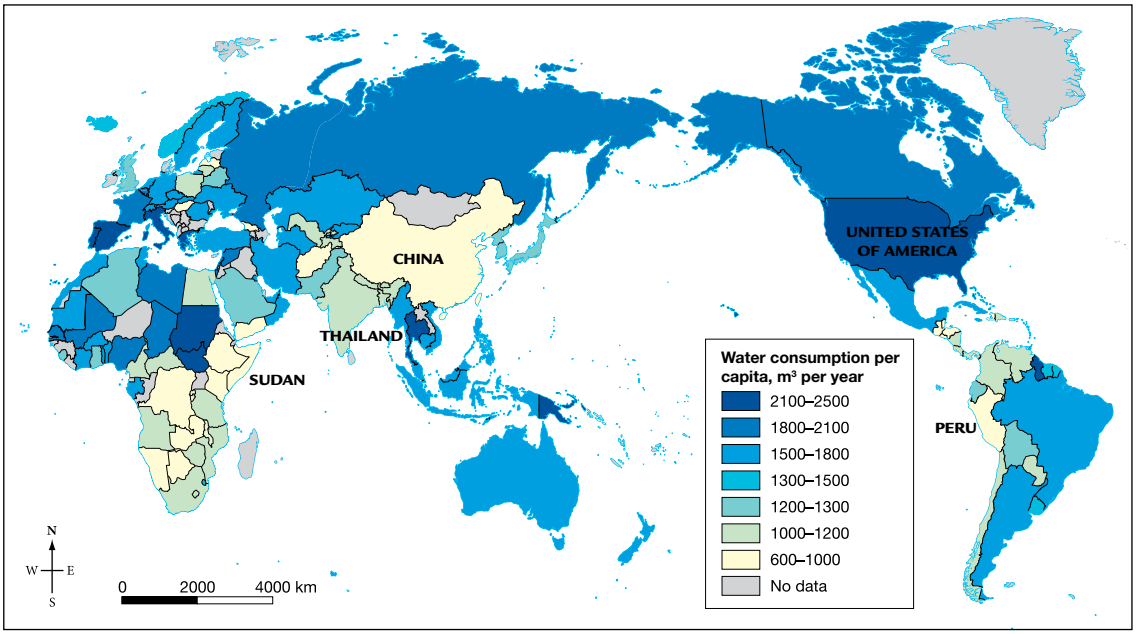
The world average water footprint is 1240 cubic metres per person per year. China has an annual footprint of 700 cubic metres per capita, while the United States has 2500 cubic metres per capita.

Japan, with a footprint of 1150 cubic metres per person per year, has about 65 per cent of its total water footprint outside the borders of the country, meaning a lot of its water is imported in the form of consumer goods and food. On the other hand, only about seven per cent of the Chinese water footprint falls outside China.

TABLE 1 The water used to grow food varies from product to product.

Food item	Unit	Global average water (litres)	Food item	Unit	Global average water (litres)	Food item	Unit	Global average water (litres)
Apple or pear	1 kg	700	Cucumber or pumpkin	1 kg	240	Olives	1 kg	4400
Barley	1 kg	1300	Dates	1 kg	3000	Orange	1	50
Banana	1 kg	860	Eggs	1	200	Paper	1 A4 sheet	10
Beef	1 kg	15500	Goat meat	1 kg	4000	Peach or nectarine	1 kg	1200
Beer (from barley)	250 mL	75	Groundnuts (in shell)	1 kg	3100	Pork	1 kg	4800
Bread (from wheat)	1 kg	1300	Hamburger	1	2400	Potato	1 kg	4800
Cabbage	1 kg	200	Lamb	1 kg	6100	Rice	1 kg	3400
Cheese	1 kg	5000	Leather	1 kg	16600	Soya beans	1 kg	1800
Chicken	1 kg	3900	Lettuce	1 kg	130	Sugar (from sugar cane)	1 kg	1500
Chocolate	1 kg	24000	Maize	1 kg	900	Tea	250 mL	30
Coconut	1 kg	2500	Mango	1 kg	1600	Tomato	1 kg	180
Coffee (roasted)	1 kg	21000	Millet	1 kg	5000	Wheat	1 kg	1300
Cotton shirt	1	2700	Milk	250 mL	250	Wine	125 mL	120

FIGURE 1 Average water footprints



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 Explain the difference between virtual water and a water footprint.

2 Outline the differences between blue, green and grey water.

EXPLAIN

3 Refer to figure 1.

- **a** Describe the patterns you notice over ***space*** of countries with (i) very high and high water footprints and (ii) very low and low water footprints.
- **b** How is the ***scale*** of footprints different for these groups?

4 Use a blank world map and choose two colours to show the main importers and exporters of virtual water. Describe the ***spatial*** patterns of the map you have drawn.

INVESTIGATE

5 Study table 1. Choose three meat, five grain, two dairy, two non-food, four fruit, four vegetable and two processed products from the list. Create a bar graph to show how much water is used to produce a vegetarian diet and a meat-based diet. Which diet uses more water?

6 Use the **Just add water** weblink in your eBookPLUS to listen to an audio program about the water footprint in food production.

- **a** What is the relationship between water-stressed countries and food production?
- **b** Give an example where the water footprint figure is in conflict with the opinion of farmers.
- **c** Find as much information as you can about a product produced in Wodonga that includes both virtual and domestic water.

APPLY

7 Conduct a debate on the following statement: That people should eat less meat in order to consume less water.

8 Compare the data for North Africa and West Asia (the Middle East) in figure 1. You could also consult maps showing global fresh water availability, distribution of global rainfall, as well as maps showing rainfall and climate in Australia. (Refer to the 'Regions' resource in your eBookPLUS.) Write three summary statements that describe the amount of rainfall, water use (including water footprints) and water availability for these two regions. How do these patterns compare with Australia?

9 Describe how water footprints ***interconnect places*** often far away from each other.

eBookplus

Interactivity
Unreal
Use this interactivity to explore the amount of virtual water in our food.
Searchlight ID: int-3080

Weblink
Just add water

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Our water footprint

13.13 How is water valued in Noosa?

13.13.1 Noosa's beaches and river

Noosa is about 140 kilometres north of Brisbane, Queensland, between the mouth of the Noosa River and the headland of Noosa National Park. Noosa demonstrates how water can have value in different ways.

FIGURE 1 Visitors enjoy the spectacular views from Noosa National Park.



Noosa is a popular tourist destination and, as such, the water at nearby beaches and in local rivers and lakes contributes an economic value to the area. Hotels with water views will charge tourists higher prices than rooms without water views. Similarly, Noosa's water has an aesthetic value — it is visually appealing and is part of the attraction of Noosa. People enjoy looking out into the ocean or over the river. The psychological and cultural value of water helps visitors relax and unwind, and the many water-based activities in Noosa such as cruises, canoeing and kite-surfing contribute to the culture of place.

FIGURE 2 An oblique aerial photograph of Noosa

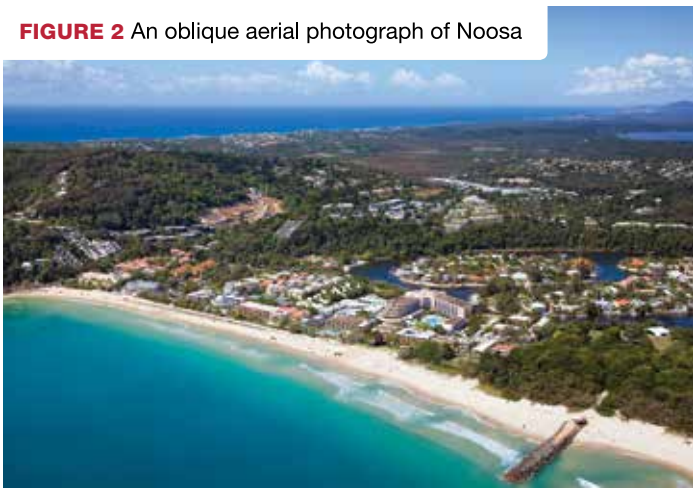
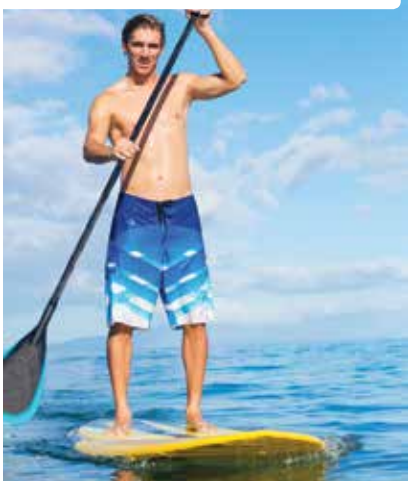


FIGURE 3 Many activities for holiday makers at Noosa are water-based.



ACTIVITIES

IDENTIFY

1. State the ***scale*** of the map in a sentence.
2. State the contour interval of the map.
3. State the feature at the following area references:
   - **a** AR 0376
   - **b** AR 0470
   - **c** AR 0583.
4. State the distance from the breakwater at AR 0781 to the causeway at AR 0380.
5. State the altitude of:
   - **a** the spot height at AR 1081
   - **b** the sewage treatment works at AR 0878
   - **c** the caravan park at AR 0780.
6. List different ways in which people use the water around Noosa. What evidence is there for these uses on the map?

EXPLAIN

7. Explain why you think the settlements around Noosa have developed in their current locations.
8. Explain why the settlements located in AR 1079 and AR 0880 are separated.

APPLY

9. Throughout this chapter we have examined the economic, aesthetic, cultural and spiritual value of water. How do you think the settlement patterns around Noosa have been influenced by:
   - **a** the economic value of water
   - **b** the aesthetic value of water
   - **c** the cultural and spiritual value of water?

PREDICT

10. Predict how increased tourism and development around Noosa may have an impact on the value of water in the future.

FIGURE 4 Topographic map of Noosa



Source: Department of Natural Resources and Mines, QLD.

eBook*plus* ONLINE ONLY

13.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au.**

13.3 SkillBuilder: Drawing a line graph

13.3.1 Tell me

What is a line graph?

A line graph displays information as a series of points on a graph that are joined to form a line. A line graph can be drawn by hand or by using a spreadsheet program such as Excel.

Why are line graphs useful?

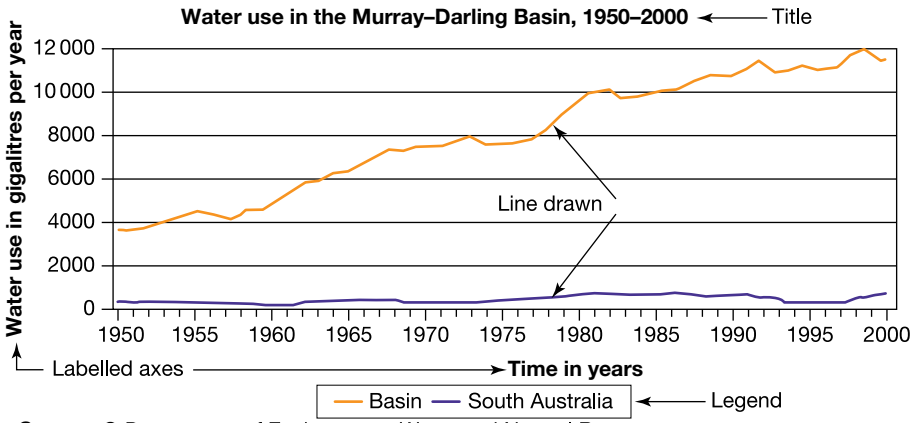
Line graphs are very useful to show change over time. They can show a single set of data, or they can show multiple sets based on a common theme such as water use in the Murray–Darling Basin compared to water use in South Australia (see the example below). This enables us to compare similarities and differences between two sets of data at a glance.

Model

A good line graph has:

- been drawn in pencil
- an appropriate scale to show the data clearly
- labelled axes
- used small dots joined by a line to make a smooth curve
- a legend, if necessary
- a clear and accurate title that explains the purpose of the graph
- the source of the data.

FIGURE 1 Water use in the Murray–Darling Basin



Source: © Department of Environment, Water and Natural Resources, South Australia Government ← Source

13.3.2 Show me

How to complete a line graph

You will need:

- data (table 1)
- graph paper
- a pencil
- a ruler.

TABLE 1 Use of rainwater tanks by household, 2001–2010

Year	Use of rainwater tanks by household (%)
2001	16
2004	17
2007	19
2010	26

Source: © Australian Bureau of Statistics

eBook*plus*

eLesson
Drawing a line graph
Searchlight ID: eles-1635

Procedure:

STEP 1

Select the data you wish to compare or interpret.

Draw a horizontal and vertical axis using a ruler.

Evenly space and then label the years along the horizontal axis. Look carefully at your range of data and work out appropriate increments for the vertical axis, then evenly space and label this information on the axis. Start at zero where the axes join.

STEP 2

Label the X (horizontal) and Y (vertical) axes.

Plot the statistics. Draw a dot at the point where the year on the horizontal axis meets the relevant position on the vertical axis. Once you have plotted all the statistics, join the dots. This can be done freehand or using a ruler.

STEP 3

Add a title and a source to the graph.

eBook*plus*

Interactivity
Drawing a line graph
Searchlight ID: int-3131

13.3.3 Let me do it

Developing my skills

Use the data in table 2 to create a line graph.

You will need:

- graph paper
- pencil
- ruler.

Questions

1. In which year is water consumption lowest?
2. Describe the pattern shown by the graph.
3. What reasons might explain the changes from 2001 and 2009?
4. When water restrictions were lifted in 2011, predict what happened to water consumption.
5. If the government made every household adopt water saving measures in 2020, what might happen to water consumption?
6. Find statistics for water consumption for your area and compare these to another area.
7. Explain how useful the graph was in helping you understand the changes that occurred to water consumption in South Australia compared to reading a table of figures.

TABLE 2 Daily residential water consumption for South Australia

Year	Daily residential water consumption (litres)
2001	539
2002	502
2003	532
2004	460
2005	465
2005	440
2007	413
2008	410
2009	395

Source: SA Water, Annual Reports

Checklist

I have:

- labelled the axes
- provided a clear title and source
- plotted the data accurately
- joined the points with a smooth line.

Skills questions

1. The increments on the vertical axis of a line graph should:
   a. be unevenly spaced
   b. be evenly spaced
   c. start with the lowest figure to be plotted
   d. all of the above.
2. Which statement about line graphs is **true**?
   a. You do not need to state the source of data.
   b. Time should always be shown on the vertical axis.
   c. Line graphs are useful to show where things are located.
   d. A clear title is essential so that the reader can understand the data presented.
3. Explain why drawing a line graph is useful.
4. Why is it important to label the vertical axis?

13.5 SkillBuilder: Annotating a photograph

13.5.1 Tell me

Using annotated photographs in geography

Photographs are used to show aspects of a place. Photographs don't give us all the information though. Often people will notice different elements in the same photograph depending on their interest and knowledge. **Annotations** are added to photographs to draw the reader's attention to what can be seen and deduced. As you can see in figure 1, we know that there was water in the Campaspe River at the time the photograph was taken. We don't know what the water quality was like. Photographs today are digital and can easily be resized and cropped.

FIGURE 1 Campaspe River near Axedale



Source: Taken by Mattinbgn, 17 March 2012. © Creative Commons

Why use annotated photographs?

Annotated photographs are useful in geographical inquiries as geographers are interested in analysing places and photographs provide a snapshot at a point in time. The annotations are vital to fully understanding the photograph. It's also important to understand that the angle a photograph is taken from, and the time it is taken, can affect how easy it is to see some aspects in the photograph. You should consider the angle the photograph was taken from, and what might be outside the border of the photograph. When photographs are used to show spatial change over time, the same views are photographed at different times, and the annotations are used to highlight the changes.

Model

A good annotated photograph includes:

- a clear title that includes the location of the photograph
- labels of the main features
- annotated processes if known
- date and time of when the photograph was taken
- the source of information — the photographer's name.

eBookplus

eLesson
Annotating a photograph
Searchlight ID: eles-1633

13.5.2 Show me

How to annotate a photograph

You will need:

- a photograph (figure 2)
- a black fine-line felt-tipped pen
- a ruler.

FIGURE 2 Annotating a photograph



Source: Taken by Paul Humphries, 5 February 2012 © Paul Humphries

Procedure:

STEP 1

Examine the photograph carefully, looking for key information it is showing you. You will notice that in this particular image above, there is evidence that it was taken during a low flow period because the water line is below the line of trees that mark a higher water level. Previous high flow or perhaps flood events of the river is shown by the large logs deposited in the currently dry bed of the river.

STEP 2

Check the date the photograph was taken. This photograph is tagged 5 February 2012. The author is Paul Humphries and the location is Campaspe River at Strathallen; therefore, a clear title might be *Campaspe River at Strathallen during summer low flow period*. Provide the source underneath as this enables the reader to understand its author and the time of year. In this case it is '*Source:* Taken by Paul Humphries, 5 February 2012.'

eBookplus

Interactivity
Annotating a photograph
Searchlight ID: int-3129

STEP 3

Add labels to the image, focusing on the key aspects you wish the viewer to notice. These might include *River in low flow*, *Debris deposited in high flow*, *Gum trees*. It is often much easier to add labels if you took the photograph and made field notes while you were there. For example, you could have determined if the river was flowing and in which direction. Labels should be placed outside the photograph with fine lines to the feature.

13.5.3 Let me do it

Developing my skills

Annotate the following photograph. Label any physical processes that you can see. For example, the river is flowing towards the foreground of this photograph. Label the human activities that are shown.

FIGURE 3 Yarra River, Melbourne, Australia



Source: Taken by Russell Moseley at 5 pm on 10 September 2012. © Russell Moseley http://www.free-things-to-do-melbourne.com

Questions

1. Name two activities that you can see.
2. What are the tall poles for?
3. Where are boats stored? How do you know?
4. What is the landing platform made of?
5. Give evidence to support the idea that rivers such as this are an important resource for people.

Checklist

I have:

- included a clear title that includes the location of the photograph
- labelled the main features
- included annotated processes, if known
- included the date and time of when the photograph was taken
- provided the source of the information.

Skills questions

1. Annotated photographs are used to:
   a. compare quantities
   b. calculate the height above sea level
   c. show a place at a point in time
   d. test water quality.

2. An annotated photograph would be best to show information about:
   a. the number of whales in different areas
   b. how population has changed in the last 100 years
   c. human activities at a place at one point in time
   d. wind speed.
3. Why is it better to place the labels outside the photograph rather than on the photograph?
4. Why is it important to carefully choose the angle at which you will take the photograph?

13.14 Review

13.14.1 Review

1. Which activity uses the highest amount of water in most countries including Australia?
2. 'As world population increases, we are going to have to produce more food with less water.' Do you agree or disagree with this statement? Justify this by using examples from this chapter.
3. What are factors that can affect the value of water?
4. Describe how water can have value to economies in countries such as Vietnam, Indonesia and Thailand.
5. Describe ways that water can have value to human health.
6. Explain how water has a cultural and spiritual value to Aboriginal people in Oodnadatta.
7. Define the word *aesthetic*.
8. Explain how the Great Barrier Reef has aesthetic value.
9. What is virtual water?
10. Explain the difference between virtual water and a water footprint. Does Australia have a large water footprint? Compare Australia with three other countries.
11. Using text, diagrams, maps and other illustrations, create an infographic or prepare a poster to illustrate the value of water in your life. Consider how water is used in the kitchen, bathroom, laundry, in the garden and in your community.
12. Describe a fieldwork technique for assessing the value of water.

13.14.2 Reflect

FIGURE 1 Water is essential to our survival and has cultural, spiritual and economic value



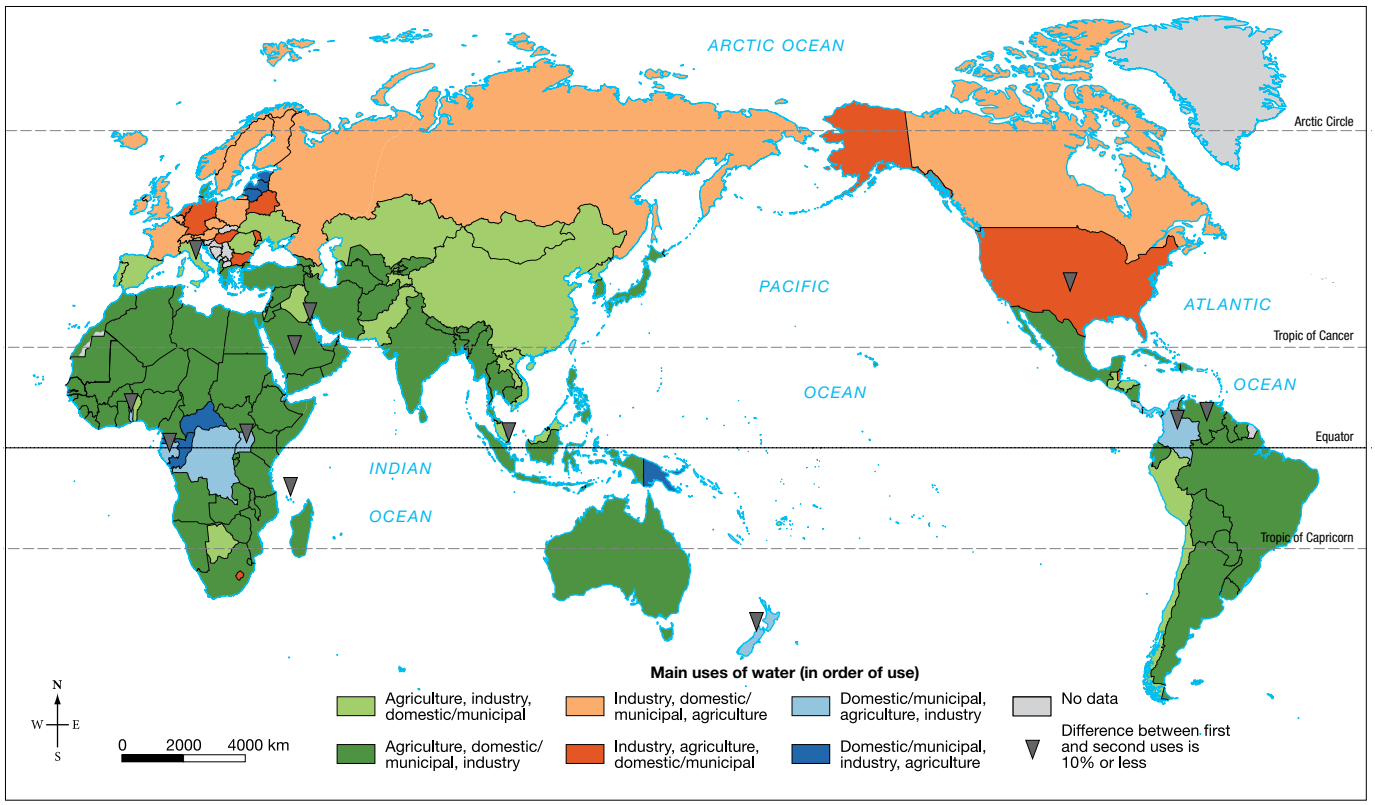
13. Go to **The value of water** weblink in the Resources tab. Examine how much water is required for different activities and to produce the different foods that you eat. Reflect on the way you use water. Are there times when you waste water? Are there ways you could reduce your water use? How could you change your behaviour to conserve water? Create an advertising campaign to teach others about ways to conserve water in the home.

eBook*plus*

Weblink
The value of water

14. We have examined the economic value of water in subtopic 13.6. Study figure 2 below (figure 1 from subtopic 13.2 'How is water used by people?') and answer the questions that follow.
    a. Figure 2 shows how different countries use water. Describe any patterns in water use that you can observe.
    b. Identify the dominant water use in high-latitude areas of the northern hemisphere. Why do you think this type of use is dominant?
    c. Suggest reasons why there are some countries with no data available.

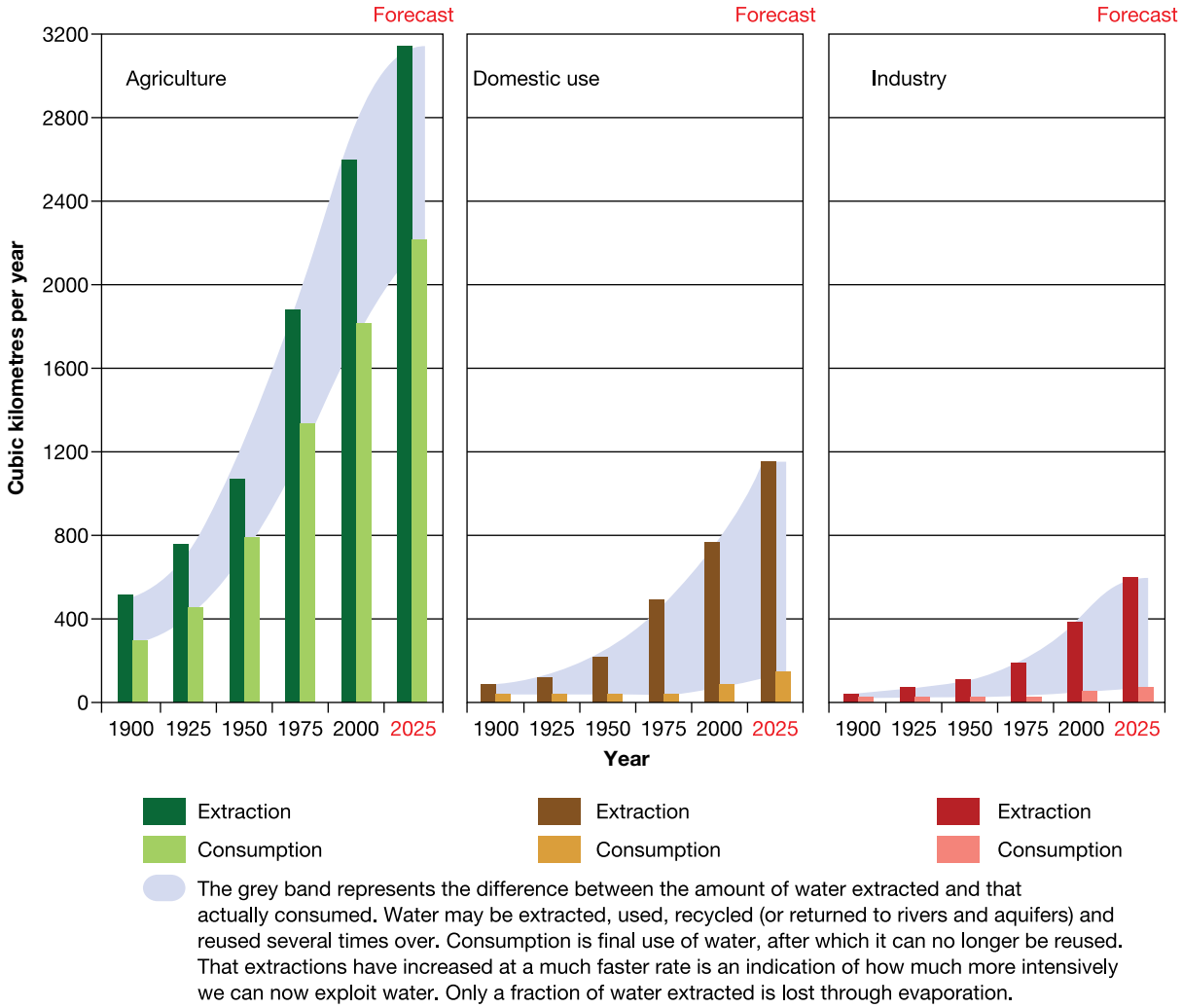
FIGURE 2 Countries in the world differ in their use of water.



Source: Mekonnen, M.M. and Hoekstra, A.Y. 2011, 'National water footprint accounts: the green, blue and gray water footprint of production and consumption', Value of Water Research Report Series No. 50, UNESCO-IHE, Delft, the Netherlands

15. Examine figure 3.
    a. Identify the main use of freshwater globally in 2000 and 2025.
    b. Identify how much water was extracted for use by industry in 1950 and 2000.
    c. Identify the difference between the amount of water expected to be extracted and the amount expected to be consumed for domestic use in 2025.
    d. Refer to the information below the diagram in figure 3. What is the difference between extraction of freshwater and consumption of freshwater?
    e. Describe how consumption and extraction affect the value of water.
    f. A large amount of freshwater extracted for domestic use can be reused or recycled. Describe strategies that enable domestic water to be reused or recycled.

FIGURE 3 Extraction and consumption of water for agriculture, domestic use and industry





This wetland environment has been transformed by water scarcity.

CHAPTER 14

Water scarcity and management

14.1 Overview

14.1.1 Introduction

Every person on the planet interacts with the weather on a daily basis. Sometimes we feel hot, sometimes we feel cold. Climate patterns affect water availability in Australia and around the world. Change in the weather and climate patterns also affects the environment. If there is too little rain, drought can develop, sometimes producing heatwaves — days of dry, hot weather. If there is too much rain, flooding will occur. Changes to climate patterns can make water availability very unpredictable, and places that once had water readily available may now suffer from water scarcity. Water management can help communities and individuals gain more predictable access to water.

Starter questions

1. List three things you would expect to happen if an area did not get its usual rainfall for a long time.
2. How would water scarcity impact on the way you live your life?
3. List two natural ***environments*** that have very little water. Name where they are or show their location on a map.
4. What are ways you could manage water use in your own home?

Inquiry sequence

		Syllabus outcomes
14.1 Overview		
14.2 Where are Australia's water resources?		GE4-1, GE4-2, GE4-7, GE4-8
14.3 How does Australia's climate affect water availability?		GE4-1, GE4-2, GE4-7, GE4-8
14.4 What differences are there in water availability globally?		GE4-1, GE4-2, GE4-7, GE4-8
14.5 Does everyone have enough water?		GE4-3
14.6 SkillBuilder: Constructing a pie graph	eBookplus ONLINE ONLY	GE4-7, GE 4-8
14.7 What is water scarcity?		GE4-3
14.8 SkillBuilder: Reading and describing basic choropleth maps	eBookplus ONLINE ONLY	GE4-7, GE 4-8
14.9 What strategies can address water scarcity?		GE4-3, GE4-5
14.10 How can water be managed?		GE4-3, GE4-5
14.11 Investigating topographic maps: What are sources of water at Whataroa?		GE4-3, GE4-5
14.12 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

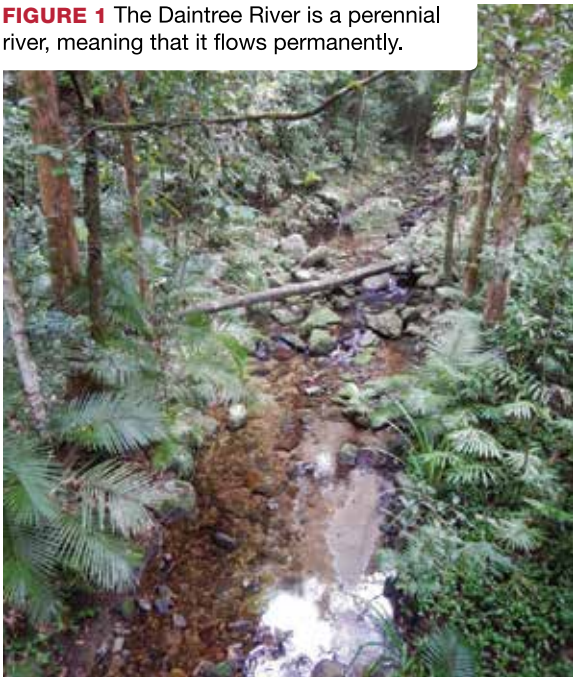
Watch this video
Of droughts and flooding rains
Searchlight ID: eles-1617

14.2 Where are Australia's water resources?

14.2.1 Australia's rivers and lakes

The amount of water on Earth has not changed since the beginning of time; there is only a finite, or fixed, amount. The water used by ancient and extinct animals and plants millions of years ago is the same water that falls today as rain. The amount of water cannot be increased or decreased. It is cycled and recycled, and constantly changes its state from gas, to liquid, to solid and back.

FIGURE 1 The Daintree River is a perennial river, meaning that it flows permanently.



Water is a resource. Like any other resource, it has no value in itself, but has great value when a use is found for it. Environments where water is found are also a resource. A river can be the site of a settlement that provides transport as well as food. A riverine environment that includes fish, birds, wildlife, wetlands, plants and micro-organisms is also valuable as a living system and can therefore be regarded as a resource.

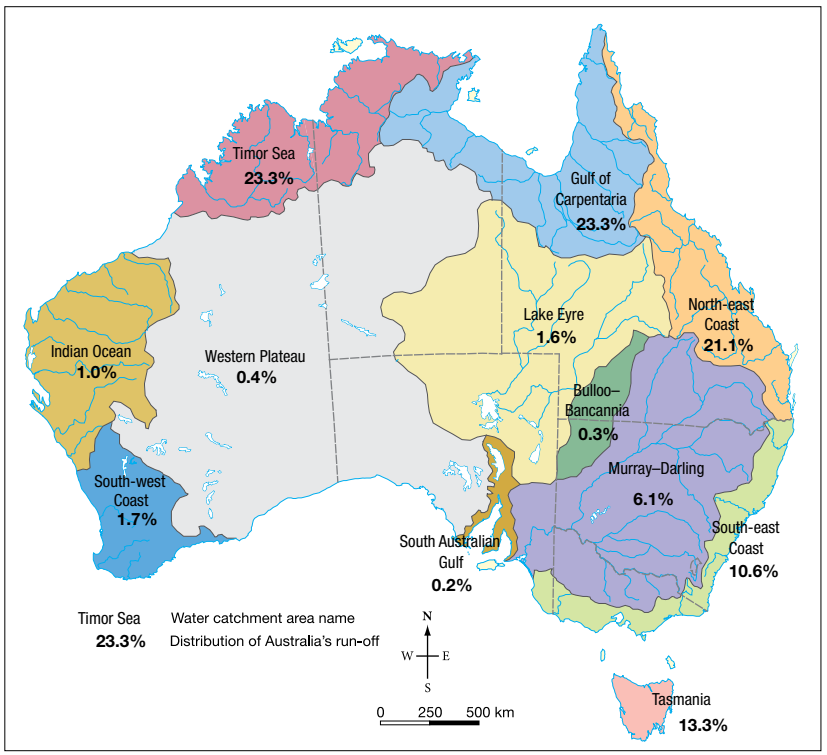
Australia has limited freshwater resources.

Australia's rivers

Rivers can be either perennial (permanent flow) or non-perennial (only flow at certain times, usually seasonally). Many rivers in Australia are non-perennial, particularly in drier parts of the continent. Only a small proportion of rainfall received makes its way into river systems, and as a result the flow of rivers in Australia is extremely variable.

The area of land which contributes water to a river and its tributaries is called a drainage basin. Major drainage basins (large catchments) in Australia are shown in figure 2. The major rivers in Australia are shown in the table below.

FIGURE 2 Australia's drainage basins



Source: MAPgraphics Pty Ltd Brisbane

TABLE 1 Major rivers in Australia

Major rivers	States
Murray–Darling	New South Wales, South Australia, Victoria
Murrumbidgee	New South Wales, Australian Capital Territory
Lachlan	New South Wales
Cooper	Queensland, South Australia
Flinders	Queensland
Diamantina	Queensland, South Australia
Gascoyne	Western Australia
Goulburn	Victoria

Australia's lakes

Australia's largest lakes are Lake Eyre and Lake Torrens. Generally, Australia's lakes do not hold much water compared to lakes found elsewhere around the world.

FOCUS ON FIELDWORK

How does water flow around your school?

Prepare a tour of your school site that includes a visit to a grassed area and a location that has little or no vegetation covering.

Field site 1: Grassed area

1 Photograph your field site
2 Gently pour water onto a grassed surface area. Record and observe what happens to the water flow.
3 Scoop a small sample of the soil into the jar and shake it.

Field site 2: Area with little or no vegetation

1 Photograph your field site
2 Gently pour water onto an area with little or no vegetation. Record and observe what happens to the water flow.
3 Scoop a small sample of the soil into the jar and shake it.
4 Describe the difference in water run-off and infiltration between the two field sites.
5 Annotate your photographs from your fieldwork demonstrating water movements, pooling and areas of infiltration.
6 Describe and explain the characteristics of the soil samples from your field sites. You may comment on moisture, soil texture, the location where the sample was collected.
7 Predict how the water movements may change with a surface that is already wet.
8 In a catchment, heavy rainfall creates fast-flowing and murky water flow. What do you think the impact of this will be?

ACTIVITIES

IDENTIFY

1 What is a drainage basin?
2 What is the difference between perennial and non-perennial rivers?
3 Locate significant rivers in Australia including the Burdekin, the Hunter, the Daly, Victoria, the Gascoyne, Ord, Fitzroy, Leichhardt, Tamar and Derwent.

EXPLAIN

4 Choose one of the rivers listed in question 3, or in the table. Create a multimedia presentation that follows the flow of the river from its source to the mouth of the river. Describe the size of the river, ***environments*** it passes through, settlements and important features along the river.

INVESTIGATE

5 Visit the **Australian Groundwater Explorer** weblink in your eBookPLUS.

You can manoeuvre around the map and zoom in and out using just buttons on the map.

In the left-hand column you can select the information you would like displayed on the map as different map layers. Click on the boxes to choose the layer you want to display. Explore the location of river regions, groundwater management areas and sedimentary basins.

Along the top of the map you can see a range of icons that give you extra functionality.

Write a summary of the location of Australia's groundwater resources.

eBookplus

Weblink
Australian Groundwater Explorer

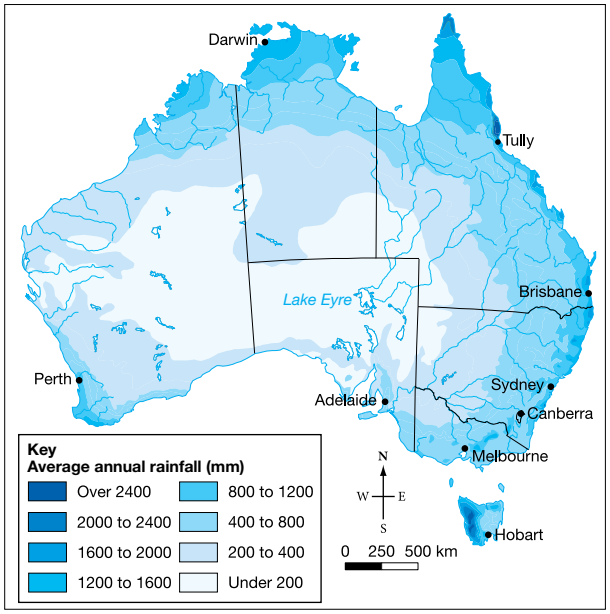
14.3 How does Australia's climate affect water availability?

14.3.1 Dry, variable and evaporated

Australia's **climate** is the most important factor affecting how much water is available for drinking, use by humans, for plant growth, in river flows and a range of other purposes. Australia is the driest inhabited continent (only Antarctica is drier), and there is very little fresh water available for our use. Rain falls unevenly across the country and from season to season.

climate long-term weather patterns in an area

FIGURE 1 The amount of rain that falls in Australia varies from place to place, as this rainfall map shows.



Source: Spatial Vision

The driest part of Australia is around the Lake Eyre Basin, and the wettest locations are places in north-east Queensland and western Tasmania. Rainfall is also highly variable, meaning that the amount of rainfall can vary or change from year to year. For example, one year a location might have very high rainfall, the next year it might have very low rainfall, and the following might be an average year.

rainfall variability the change from year to year in the amount of rainfall in a given location

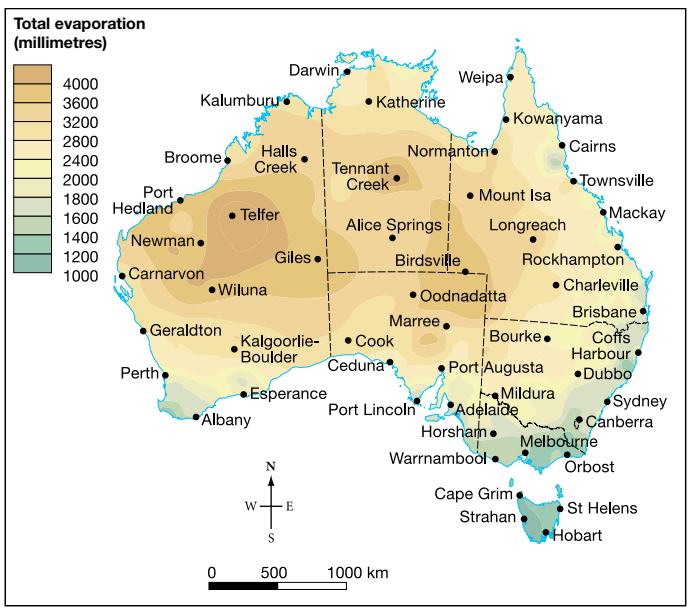
Rainfall variability is the way rainfall totals in a given area vary from year to year. For example, if an area has low rainfall variability, it means rainfall will tend to be fairly consistent from one year to the next. Many coastal areas show this kind of rainfall pattern. In contrast, high rainfall variability means rainfall is likely to be irregular from one year to the next; there may be heavy rainfall in some years and little or no rainfall in others. Desert areas in central Australia tend to have low rainfall and high rainfall variability.

Australia's seasons result in variations in rainfall. In northern Australia a wet season is experienced from November to April, and a dry season from May to October. Some parts of southern and south-western Australia experience winter rain peaks. Rainfall is more evenly distributed throughout the year in most parts of Australia.

Another problem for Australia is that most of its rainfall does not end up in rivers; much of it evaporates. Of all the water carried by the world's rivers, Australian rivers contain only one per cent of that total — even though Australia has five per cent of the world's land area. On average, only 10 per cent of our rainfall runs off into rivers and streams or is stored as groundwater. This figure drops to 3 per cent in dry areas and rises to 24 per cent in wetter places. The rest evaporates, is used by plants, or is stored in lakes, wetlands or underground storages. Areas in central Australia are very dry and, as a result, have high **evaporation** rates. Coastal areas have lower evaporation rates because they are close to the sea.

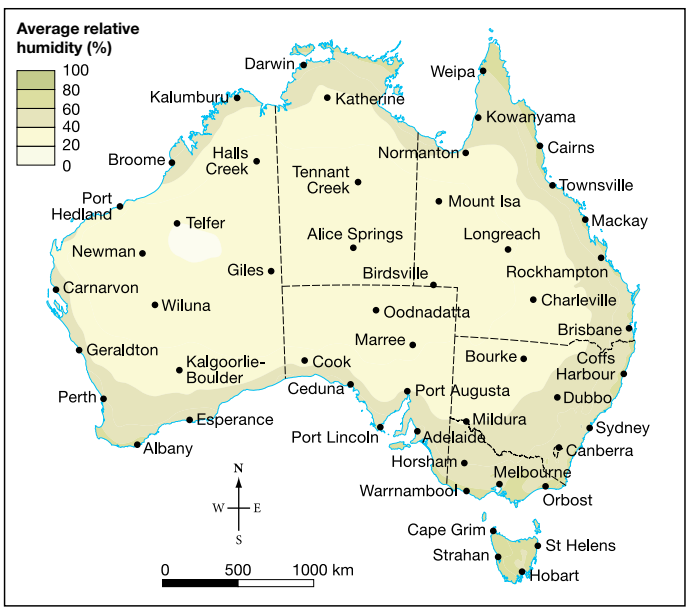
evaporation the process by which water is converted from a liquid to a gas and thereby moves from land and surface water into the atmosphere

FIGURE 2 Average annual evaporation, Australia



Source: Spatial Vision

FIGURE 3 Average relative humidity across Australia



Source: Spatial Vision

Relative humidity is a measure of the air's moisture content expressed as a percentage of the maximum moisture the air can contain at a certain temperature. Keep in mind that warm air can contain more moisture than cool air. Relative humidity does not measure the exact amount of moisture in the air because that depends on air temperature. For example, if Brisbane has a day of 30 °C and Melbourne has a day of 15 °C, and the relative humidity in both places is 60 per cent, there will be much more moisture in the air in Brisbane than in Melbourne.

Relative humidity tends to be higher in coastal regions, as is rainfall. Relative humidity tends to be higher in the parts of Australia that have very high rainfall, such as north Queensland and western Tasmania.

relative humidity the amount of moisture in the air

FOCUS ON FIELDWORK

Weather conditions

In small groups, without looking directly at the sun, observe the atmosphere above your school over a period of 5 days.

- Measure and record the temperature of the air using a thermometer.
- Measure and record wind direction.
- Estimate the percentage of the sky covered by cloud.
- Create a cloud identification chart or use the **Cloud identification** weblink in your eBookPLUS to help you identify the cloud type.

Prepare and complete a table like the one below to record your findings.

Date	Time	Air temperature (°C)	Wind direction	Cloud cover (%)	Cloud type

1 Is there a pattern that emerges from your findings?
2 Why do you think this may be the case?

eBookplus

Interactivity
Hot and dry
Use this interactivity to learn more about the interconnection between rainfall and evaporation in Australia.
Searchlight ID: int-3081

Weblink
Cloud identification

ACTIVITIES

IDENTIFY

1 Which two regions receive the most rainfall in Australia?
2 Which two regions receive the least rainfall in Australia?
3 Which region has the most variable rainfall?
4 What is rainfall variability?
5 What is relative humidity? Use figure 3 to find the relative humidity of the ***place*** where you live.

EXPLAIN

6 Why does Australia have high evaporation rates?
7 Study the rainfall, humidity and evaporation maps. Fill in the missing word in the following statements in order to describe the ***interconnections*** between these features of our climate.
Areas with low rainfall and low humidity tend to have a _____ evaporation rate.
Areas with high rainfall and high humidity tend to have a _____ evaporation rate.

INVESTIGATE

8 Find the ***place*** where you live on the map of Australia. Study the three maps in this section and complete a table like the one below. Compare where you live with another ***place*** in your state or territory and a place a long way from where you live.
9 Find out the average rainfall for Lake Eyre and the wettest locations and heaviest rainfalls in north-east Queensland and western Tasmania. Record the rainfall variability, evaporation and relative humidity. What differences are there between these locations?
10 Australia has high evaporation rates and high rainfall variability. List all the ways that this ***environment*** makes water delivery to people a challenge.

	Average rainfall	Rainfall variability	Average annual evaporation	Relative humidity
Where I live: _____				
Another place in my state/territory: _____				
A place far from where I live: _____				

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **› Australia: weather and climate**

14.4 What differences are there in water availability globally?

eBookplus

Weblink
Planet Earth, fresh water

14.4.1 Where is the world's water?

Water is not evenly distributed around the world, and is not equally available at all times. Many areas of the world have inadequate water supply to address the needs of the population. Many places have high annual rainfall averages meaning that they have periods with high rainfall and high water availability, and other periods of low rainfall and low water availability. Nearly 70 per cent of the world's fresh water is stored in glaciers and ice caps, and as a result is not readily available for human use.

drainage basin the entire area of land that contributes water to a river and its tributaries



FIGURE 1 Gargantuan swimming pools are on the rise in luxury resorts around the world.

The factors that have an impact on water availability are latitude, altitude, ocean currents, distance from the sea, geology, topography and climate change. This is discussed in subtopic 12.8. Use the **Planet Earth, fresh water** weblink in your eBookPLUS to find out more about water.

14.4.2 The world's largest swimming pool

The man-made lagoon in Citystars Resort, Sharm el-Sheikh, Egypt, covers an area of 9.68 hectares or 120 000 m^2. It is a full kilometre longer than the previous record holder in San Alfonso del Mar resort, Algarrobo, Chile, which measures 1013 metres in length and holds 250 000 cubic metres of water (see figure 1).

14.4.3 The world's largest freshwater river

The Amazon River in South America is the second longest river in the world and is by far the largest by water flow. It has the largest **drainage basin** in the world and approximately one-fifth of the world's total river flow.

FIGURE 2 The river with the world's greatest water flow is the Amazon River.



The **discharge** from it is about 7000 cubic kilometres every year, or 219 million litres of water every second. In contrast, Australia's largest river in terms of water flow, the Mitchell River, discharges an average of only 12 cubic kilometres each year.

discharge the volume of water that flows through a river in a given time

14.4.4 The waterfall with the most water

The flow rate at Niagara Falls' main falls has been measured at around 2.6 million litres per second — enough water to fill an Olympic swimming pool in about one second.

14.4.5 The place on Earth with the most rainy days

The wettest place in the world (based on the average number of rainy days received each year) is Mt Wai'ale'ale in Hawaii. The summit is 1569 metres above sea level and receives over 350 days of rain each year. Mt Wai'ale'ale records an average of up to 13 000 millimetres of rain per year. In some years, rain has been known to fall for 360 days per year!

14.4.6 The wettest place in the world

The wettest place in the world (based on the yearly average total) is Mawsynram, India, which receives an average of 11 870 millimetres (nearly 12 metres) of rain each year. It has a subtropical highland climate with a long monsoon season.

14.4.7 The biggest dam

The Three Gorges Dam in China is the world's largest dam and hydro-electricity plant.

FIGURE 3 Niagara Falls



FIGURE 4 Mt Wai'ale'ale averages over 350 rainy days each year.



FIGURE 5 Women in the potato fields of Mawsynram wear rain protection made of leaves and cane.



FIGURE 6 The Three Gorges Dam produces the most hydro-electricity in the world.



14.4.8 Where is the highest number of desalination plants in the world?

Places with little water often build desalination plants to convert sea water to fresh water. The Persian Gulf has the highest number of desalination plants in the world, with Saudi Arabia the world's largest producer.

FIGURE 7 Al-Jubail, the largest desalination plant in the world, is located on the Persian Gulf in Saudi Arabia.



eBookplus

Weblink
Iguazu Falls

ACTIVITIES

IDENTIFY

1 Use the **Iguazu Falls** weblink in your eBookPLUS to watch the first half of a video about these falls.
   - **a** Where are the Iguazu Falls located?
   - **b** How wide are these falls?
   - **c** How much water flows over the falls each second when they are in flood?
   - **d** What is the size or ***scale*** of the flooded area of the Parana River?

EXPLAIN

2 How many Olympic-sized swimming pools would fit into the world's largest swimming pool? Find its location on Google Earth or in an atlas.

INVESTIGATE

3 Conduct some research to find the location and name of the longest river in the world and the river with the second-highest discharge.

4 How much does it rain where you live? How does this compare with the wettest place in the world?

5 Use a blank outline world map to locate the ***places*** mentioned in this section. Annotate your map with the water facts for which each ***place*** is famous.

6 Climate maps give you clues about why each location holds amazing records. Look at your atlas and match the location of the ***places*** with these facts. Make a list of the geographic features that contribute to each amazing fact.

7 Conduct some research to find the following information: the ***place*** in the world where the most rain fell in a single 24-hour period; the ***place*** in Australia that has the record for the wettest year; the wettest town in Australia. Compare each of these with where you live.

14.5 Does everyone have enough water?

14.5.1 The human right to water

Access to water is a human right that is protected by many international agreements, yet not everyone has access to this life-giving resource.

Everyone has the right to enough safe, accessible and affordable water for all their needs. Water is more important to survival than food. In hot conditions, a person can survive up to three weeks without food but only two or three days without water.

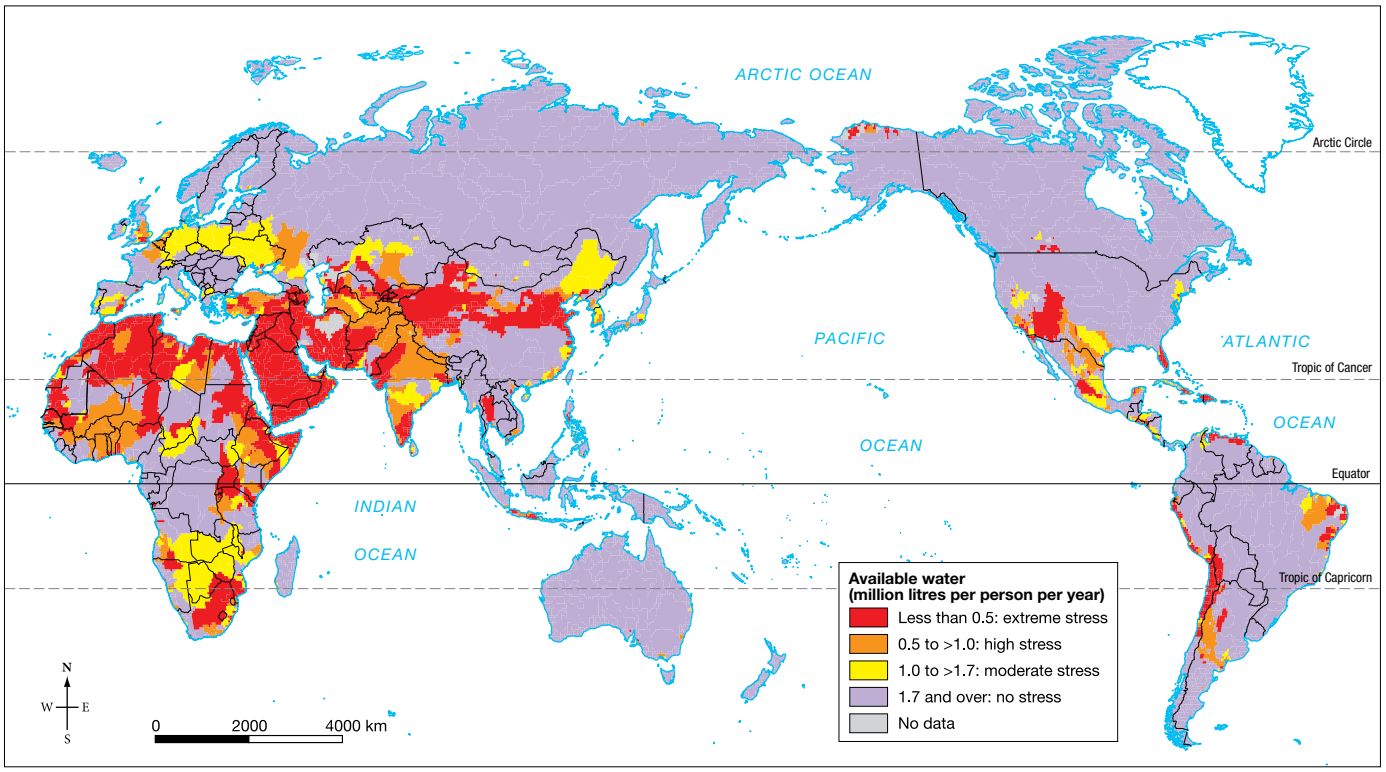
People need access to **improved drinking water**, yet over 880 million people use unclean drinking water. Water is also needed to cook food, to bathe, to wash dishes and clothes, and to flush toilets. However, with the global population increasing and a fixed amount of water on Earth, some regions are suffering water scarcity. Water scarcity occurs when the demand for water is greater than the available supply.

Ideally, each individual needs one cubic metre (1000 litres) of drinking water per year, about 100 cubic metres for other personal needs, and 1000 cubic metres to grow all the food that he or she consumes. **Water stress** occurs when there is not enough water available for all demands. A country with less than 1000 cubic metres of renewable fresh water per capita (per person) is under water stress.

improved drinking water water that is safe for human consumption

water stress a situation that occurs when annual water supplies drop below 1700 cubic metres of renewable fresh water per person

FIGURE 1 Global fresh water availability

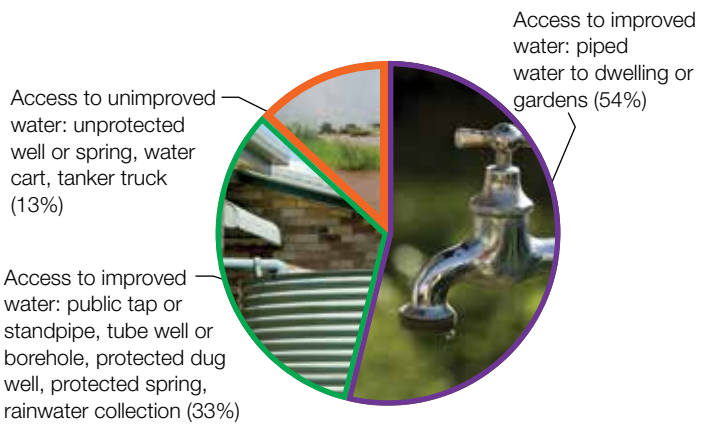


Source: Spatial Vision

Around 1.1 billion people have inadequate access to water. A major reason for this scarcity is the difference between where people live and where rain falls. Other reasons include water being used for agriculture and industry in regions where it is dry, and water being so polluted it cannot be used.

By 2025, it is estimated that two billion people will be living in regions where there is not enough water. The problem of lack of water is often worse in rural areas, so many people move from the countryside into towns and cities, hoping for a better water supply. These people are sometimes called water refugees. However, the water in some cities is also inadequate because it is in short supply or is very polluted.

FIGURE 2 Some people have access to cleaner water than others.



14.5.2 The water carriers

People who do not have water at home have to travel to get water. Water is very heavy and difficult to carry. The burden of this water-fetching usually falls on women, who carry the heavy load on their head or back. For some people, the trip to a water supply and back can take hours each day. The average distance that women in Africa and Asia walk to collect water

eBookplus

Weblink
Burden of thirst

is six kilometres. The average weight they carry on their heads is about 20 kilograms — the usual weight of a suitcase taken on a flight. The World Health Organization estimates that over 40 billion work hours are lost each year in Africa alone, just collecting drinking water.

Use the **Burden of thirst** weblink in your eBookPLUS to watch a video about water scarcity in East Africa.



FIGURE 3 Drought conditions can reduce water quantity and quality.



FIGURE 4 Women bear the burden of collecting water.

GEOskills TOOLBOX

Interpreting a pie graph

A pie graph is a circular diagram that has been divided into slices. The diagram shows data for a particular topic; for example, the total fresh water available globally. Each slice in the graph represents a proportion of the whole. Examine SkillBuilder 14.6 'Constructing a pie graph' in your eBookPLUS.

Examine figure 5.

1. State the proportion of women who collect and carry water in Africa.
2. State the proportion of children who collect and carry water in Africa.
3. Suggest reasons why a larger proportion of women and girls collect and carry water than men and boys.

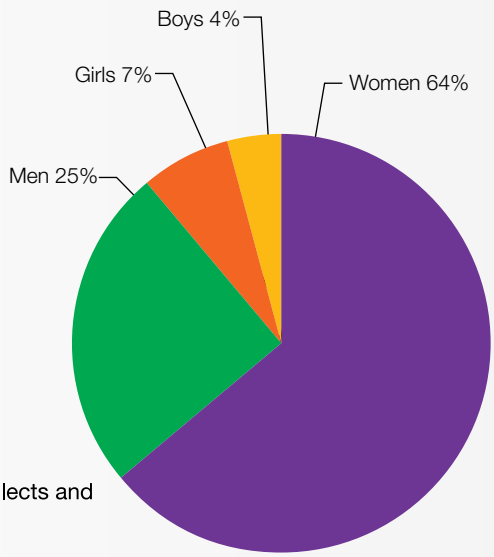


FIGURE 5 Who collects and carries the water?

ACTIVITIES

IDENTIFY

1. Why is access to water a human right?
2. Define the terms *water scarcity* and *water stress*.

EXPLAIN

3. Outline the difference between improved and unimproved water supplies.
4. Describe the impact on a country if it is under water stress or water scarcity.
5. There is a difference in water quality across Australia. Is your water supply 'improved'? Explain.
6. What might be meant by the term *water refugee*?

INVESTIGATE

7. Study figure 1. Name three countries that are water stressed and experience water scarcity.
8. Geographers like to look at patterns over ***space***. Find an atlas map showing population density and compare it with figure 1. Refer to countries in North Africa and West Asia in your answers. (Refer to the 'Regions' resource in your eBookPLUS.)
   a. Name three countries that have high population densities and are under water stress.
   b. Name three countries that have high population densities and are experiencing water scarcity.

c Name countries with low population densities experiencing water stress or scarcity.

Use figure 1 to describe water scarcity in North Africa.

APPLY

9 Study figure 5. Women are the main water carriers in ***places*** where there is water stress and scarcity. Discuss with another student how this would affect a woman's health, education, family life and food production. Draw a consequence map of your ideas.

10 Describe what the impact would be on the lives of women and children if there was a well with clean water in every village or town.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.

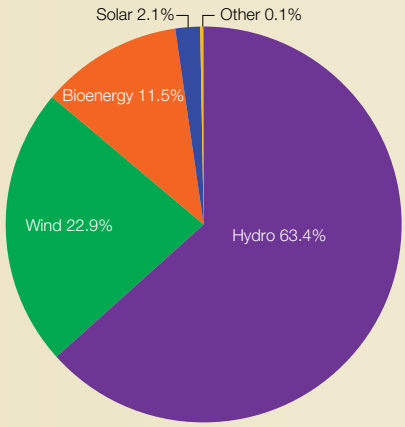
- The Dead Sea — overcoming water scarcity
- Russia and Eurasia

eBookplus ONLINE ONLY

14.6 SkillBuilder: Constructing a pie graph

What is a pie graph?

A pie graph, or pie chart, is a graph in which slices or segments represent the size of different parts that make up the whole. The size of the segments is easily seen and can be compared. Pie graphs give us an overall impression of data.



eLesson

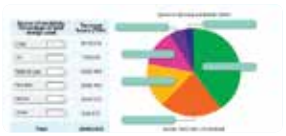
Watch this video to learn how to construct a pie graph.



Searchlight ID: eles-1632

Interactivity

Try this interactivity to learn how to construct a pie graph.



Searchlight ID: int-3128

14.7 What is water scarcity?

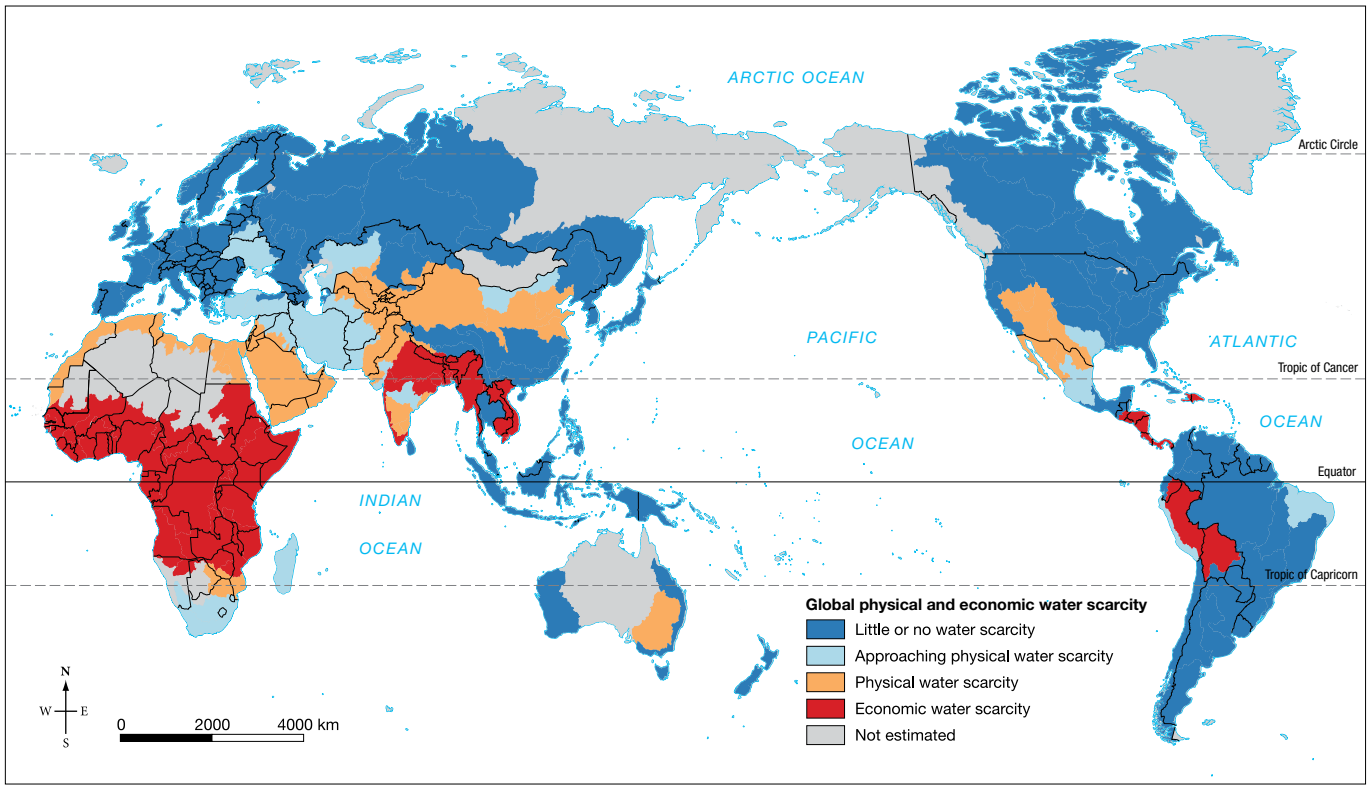
14.7.1 What are the causes of water scarcity?

Water scarcity is when a large group of people, over a long period of time, do not have access to safe, affordable water to be able to satisfy their needs for drinking, washing or their livelihoods. Globally, 1.1 billion people lack access to water and 2.7 billion find water scarce for at least a month a year. Water is vital for drinking, sanitation and food production. Water use is increasing at more than twice the rate of global population growth, and an increasing number of regions are experiencing chronic water shortages. Unsustainable use of water has resulted in stressed water systems, the drying up of lakes, aquifers and rivers, and the disappearance of over a half of the world's wetlands.

water scarcity when annual water supplies drop below 1000 cubic metres per person. *Absolute water scarcity* describes the situation when annual water supplies drop below 500 cubic metres per person.

There are two main types of water scarcity — physical and economic. Economic water scarcity results from a lack of investment in water-related infrastructure. Physical water scarcity refers to when water is not abundant enough to meet all demands.

FIGURE 1 Global physical and economic water scarcity



Source: International Water Management Institute (IWMI)

GEOskills TOOLBOX

Choropleth maps

A choropleth map uses shading and colour to show the spatial patterns of a particular theme; for example, water scarcity. It usually shows numerical data and often uses darker shades to represent abundance and lighter shades to show less of a measurement. Refer to SkillBuilder 14.8 'Reading and describing basic choropleth maps' in your eBookPLUS.

Refer to figure 1 above.

1 Describe the areas affected by little or no water scarcity.
2 Explain why these areas might have little or no water scarcity.
3 Describe the regions most affected by economic water scarcity.
4 Why do you think these regions are likely to be affected by this type of water?

Uneven distribution of water resources occurs naturally. As discussed in chapter 12, factors such as latitude, altitude, ocean currents, distance from the sea, geology and topography naturally have an impact on the amount of water available in certain places. Places that receive less rainfall are more likely to suffer from water vulnerability or water scarcity.

There is also a range of human uses that contribute to water vulnerability and water scarcity.

FIGURE 2 Water scarcity has an impact on both landscapes and environments, as seen in this mangrove area.



Population

Over 40 per cent of the world's population live in river basins that are under stress, and this is likely to increase as the world's population increases. Further pressure on local water supplies will result as people withdraw more water and pollution increases.

Agriculture

Agriculture consumes around 70 per cent of the world's accessible fresh water. Due to inefficiencies and leaky irrigation systems much of this water is wasted. Many irrigation systems draw on groundwater to supplement supplies and, as a result, many of these groundwater sources are being used at unsustainable rates and are being depleted. Farmers also use fertiliser and pesticides to help their crops grow and to reduce pests; however, when these chemicals make their way into local waterways, this can further reduce the amount of potable fresh water available.

Energy production

Every year 580 billion cubic metres of fresh water globally is used in energy production. This equates to about 15 per cent of the world's fresh water. Water is used to cool thermal power plants, in drilling and refining processes, and rivers can be diverted for hydro-electric schemes. This use can threaten both quantity and quality of water supplies. If power plants are built in areas with limited water resources, this can have direct impact on water availability for local communities. If water is used in processing, it can result in the creation of polluted water known as slurry.

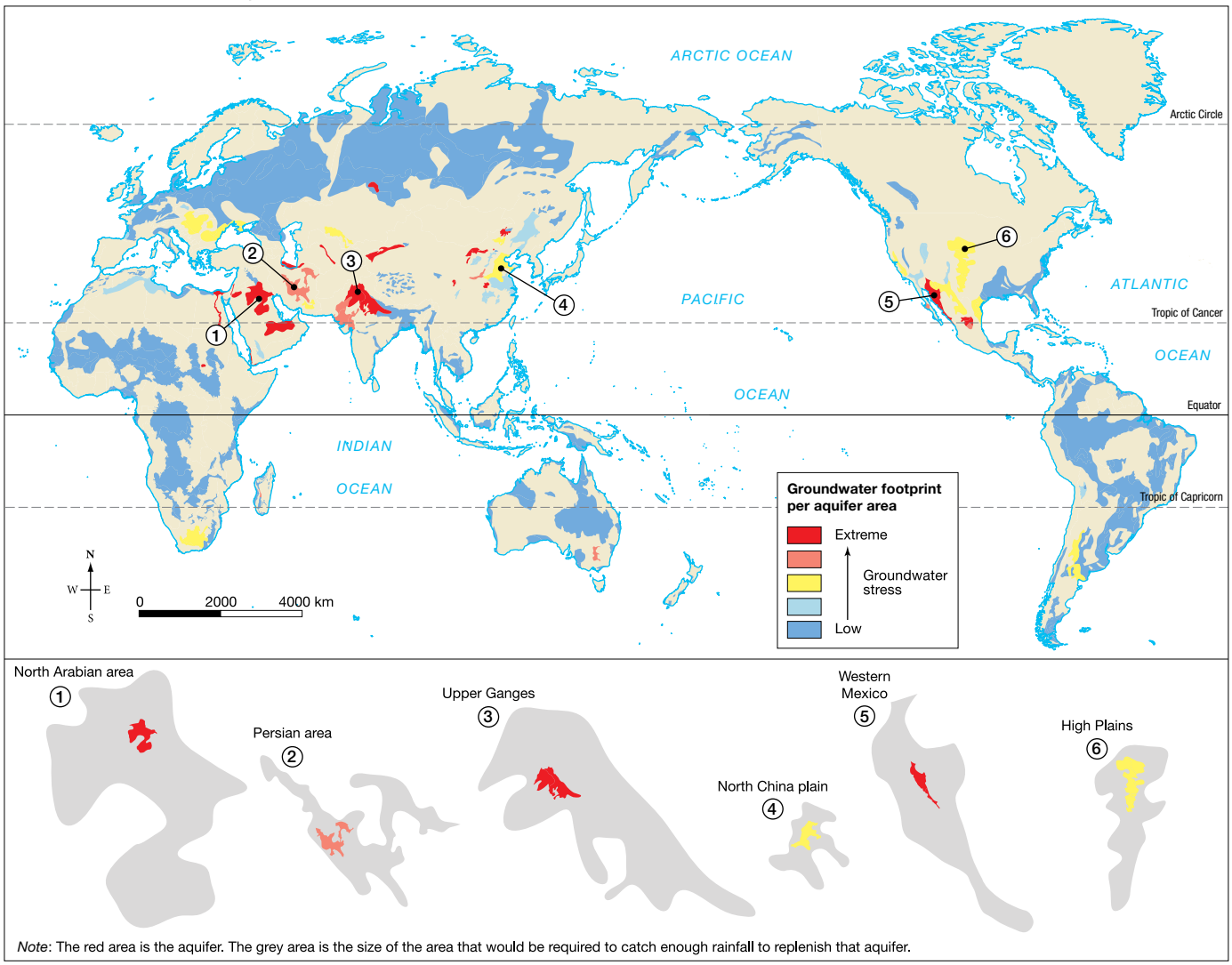
Climate change

Climate change is expected to drastically modify weather patterns, and result in an increasing number of droughts and floods in particular areas. This will make seasonal predictions and crop planning more difficult. The disappearance of glaciers and pack ice will restrict water availability in downstream communities. Based on the existing climate change scenario, it is anticipated that by 2030 half of the world's population will live in areas of high water stress. The impact of climate change on water availability will disproportionately impact on equatorial regions that rely heavily on water received from rainfall rather than irrigation for agriculture.

Ownership

There is concern regarding the sale of long-term water rights to investors along with the sale of land in some African countries such as Mali and Sudan. This jeopardises water access for local farmers, traditional water users and downstream users.

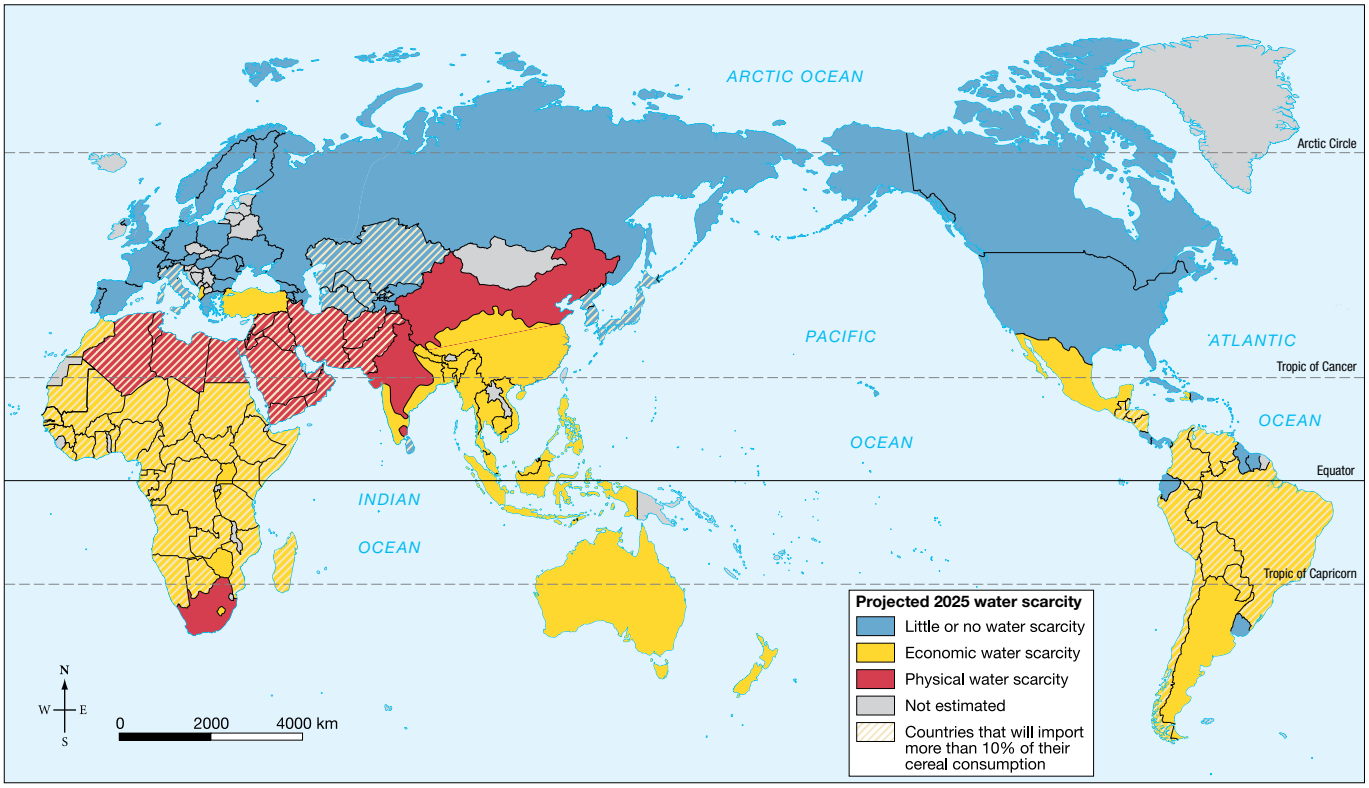
FIGURE 3 Global areas of groundwater stress



Note: The red area is the aquifer. The grey area is the size of the area that would be required to catch enough rainfall to replenish that aquifer.

Source: BGR & UNESCO 2008: Groundwater Resources of the World 1 : 25 000 000. Hannover, Paris.

FIGURE 4 Global projected water scarcity



Source: Spatial Vision

FIGURE 5 Individuals and communities are affected by water scarcity in Kathmandu.



ACTIVITIES

IDENTIFY

1 What is the difference between water scarcity and water stress?
2 What is the difference between physical water scarcity and economic water scarcity?

EXPLAIN

3 Why are there differences in water availability naturally? How do these factors result in water scarcity?
4 What is the link between water scarcity and population growth?

APPLY

5 Create a flow chart that shows how water scarcity impacts on the quality of life of people affected.
6 Examine figure 6, a cartoon on water scarcity. Describe how this demonstrates the unequal impacts of water scarcity on different regions and communities.
7 Draw your own cartoon or illustration showing the impact of water scarcity on communities or individuals.

FIGURE 6 Difference in access to water globally



PREDICT

8 How will climate ***change*** affect water scarcity in the future?

INVESTIGATE

9 Research a region or country that is likely to experience water scarcity as a result of climate ***change***. Explain the impact this will have on the quality of life of people, the economy of the region or country, and the ***environment***.

eBook*plus* ONLINE ONLY

14.8 SkillBuilder: Reading and describing basic choropleth maps

What is a basic choropleth map?

A basic choropleth map is a shaded or coloured map that shows the density or concentration of a particular aspect of an area. The key/legend shows the value of each shading or colouring. The darkest colours usually show the highest concentration, and the lightest colours usually show the lowest concentration.



eLesson
Watch this video to learn how to read and describe a basic choropleth map.



Searchlight ID: eles-1706

Interactivity
Try this interactivity to learn how to read and describe a basic choropleth map.



Searchlight ID: int-3286

14.9 What strategies can address water scarcity?

14.9.1 United Nations

In 2000, the United Nations Millennium Development Goals were set to reduce extreme poverty. Some of the targets set related to improving access to water. While 11 per cent of the world's population are still without access to safe drinking water, between 1990 and 2015 2.6 billion people gained access to improved drinking water. This was achieved through the provision of piped water supplies and protected wells. One of the Sustainable Development Goals, developed in 2015, aims to provide universal access to water and sanitation by 2030.

14.9.2 Role of governments

Governments are responsible for some of the practical management of water sources to reduce the severity of water scarcity. To achieve this, they need to create and enforce laws and fund institutions to regulate water use. Governments need to listen to the views and take into account the needs of different stakeholders such as local residents and businesses, and monitor the needs of the environment. They have to manage conflict between different groups over water use; coordinate water management across boundaries; and ensure that management zones take into account natural boundaries, such as catchments, to ensure effective management.

Governments may fund innovations in water management such as recycling, purification, 3D modelling and simulations, screens to separate salt water and fresh water, and desalination.

14.9.3 Role of non-government organisations

Non-government organisations (NGOs), such as The Water Project, provide training and finance for construction of water projects for communities in sub-Saharan Africa. This involves activities such as digging wells, constructing dams, protecting springs and water filtration.

Environmental NGOs like the World Wide Fund for Nature (WWF) undertake small-scale local projects to measure water use and the impacts of this use on river basins. They provide funding to advance the science of water conservation and promote methods of sustainable water use.

14.9.4 Role of communities

The ability of communities to address water scarcity is limited by access to funding and the much larger government structures in place. Communities can ensure that they have effective local government representation so that they are able to voice their concerns. They can collaborate with competing stakeholders to try to bring about equitable access to existing water sources.



FIGURE 1 Young children in Zambia travel many miles to fetch water for their families.

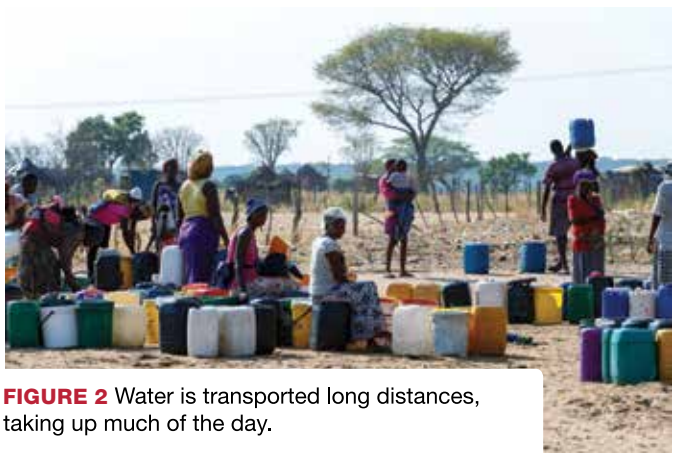


FIGURE 2 Water is transported long distances, taking up much of the day.

14.9.5 Role of individuals — what can you do?

It is generally very difficult for people in water-scarce areas to address water scarcity and options are often limited. They may be forced to drink contaminated water, or use water from the same sources that animals use to drink and bathe. Individuals and communities may become involved in conflict in their fight to maintain access to water sources. Individuals can improve their access to water by fixing leaks in pipes and taps, and reducing pollution of local water sources.

Individuals in more developed countries with abundant water sources are much more able to reduce their water consumption. They can do this by using water-efficient appliances and taps, using water-efficient methods of cooking, and reducing the use of running water in cleaning food, brushing teeth and rinsing dishes.

FOCUS ON FIELDWORK

Monitor water use at home

Locate your council water meter. If you live in an apartment or duplex, this may be on common property. As water flows through the meter it will register water usage. Measure your household water usage each day over a period of a week. For consistency, try to take the measurements at the same time each day. Note any differences in your household each day; for example, extra or fewer people.

Develop a way of recording and displaying your results and observations.

1. What was the average daily water use for your household over the measurement period?
2. What factors do you think contributed to differences in daily water usage?
3. Are there any strategies you could put in place to significantly reduce water usage in your home?
4. Research the average daily water use in five different countries. How does your average daily household water use compare to water use by people in those other countries?

FIGURE 3 A water meter in a suburban garden



ACTIVITIES

IDENTIFY

1. What proportion of the world's population is still without access to safe drinking water?

EXPLAIN

2. Explain how the Millennium Development Goals to reduce poverty relate to addressing water scarcity.
3. Describe the importance of the role of governments in helping to address water scarcity.

INVESTIGATE

4. Research one example of how an NGO has assisted a community in improving their access to fresh water. Describe the role that the NGO played, providing statistics that show how access to water was improved, and describe the impact of these changes on quality of life within the community. Include a map showing the location of the community and the project.

14.10 How can water be managed?

14.10.1 Managing our water supply

More water cannot be created, but it can be managed better. With a growing global population, and the predicted changes due to **climate change**, the pressure on this finite resource requires a number of solutions.

climate change a change in the world's climate. This can be very long term or short term, and is caused by human activity.

Introducing effective water management can be a challenge at any scale, whether local, national or global. It needs the cooperation of all users, including farmers, industry, individuals, and upstream and downstream people in different countries or different states. With all the competing demands on water, management is often easier to approach at a local scale.

Because agriculture uses the greatest amount of water, it makes sense to make irrigation systems more efficient. The aim is to get more production for every drop of water used. Some irrigation systems waste up to 70 per cent of their water through leaks and evaporation, so changing the irrigation method can save water. Other management practices include recycling, using desalinated water, and using stormwater.

Managing water across borders

About 260 drainage basins across the world are shared by two or more countries. Thirteen river basins are shared by five or more countries. Depending on their location in the catchment, some countries can suffer reduced access to water because of other countries' usage. This shows the interconnection between places — what happens in one place affects another. Diverting rivers, building dams, taking large amounts of water out for irrigation, and creating pollution can all lead to conflict between countries, states and political groups.

FIGURE 1 Kurnell desalination plant in southern Sydney provides water to the city's population. It is powered by wind energy produced in Canberra.



FIGURE 2 The Jordan River passes through three countries, and has tributaries in the north that flow in from another two countries.



Source: Spatial Vision

Country disputes have occurred in the Nile Basin in north Africa, along the Mekong River in Asia, the Jordan River Basin in West Asia (the Middle East) and along the Silala River in South America. This can also happen within a country, which has happened with the Murray–Darling Basin in Australia, across four states and one territory.

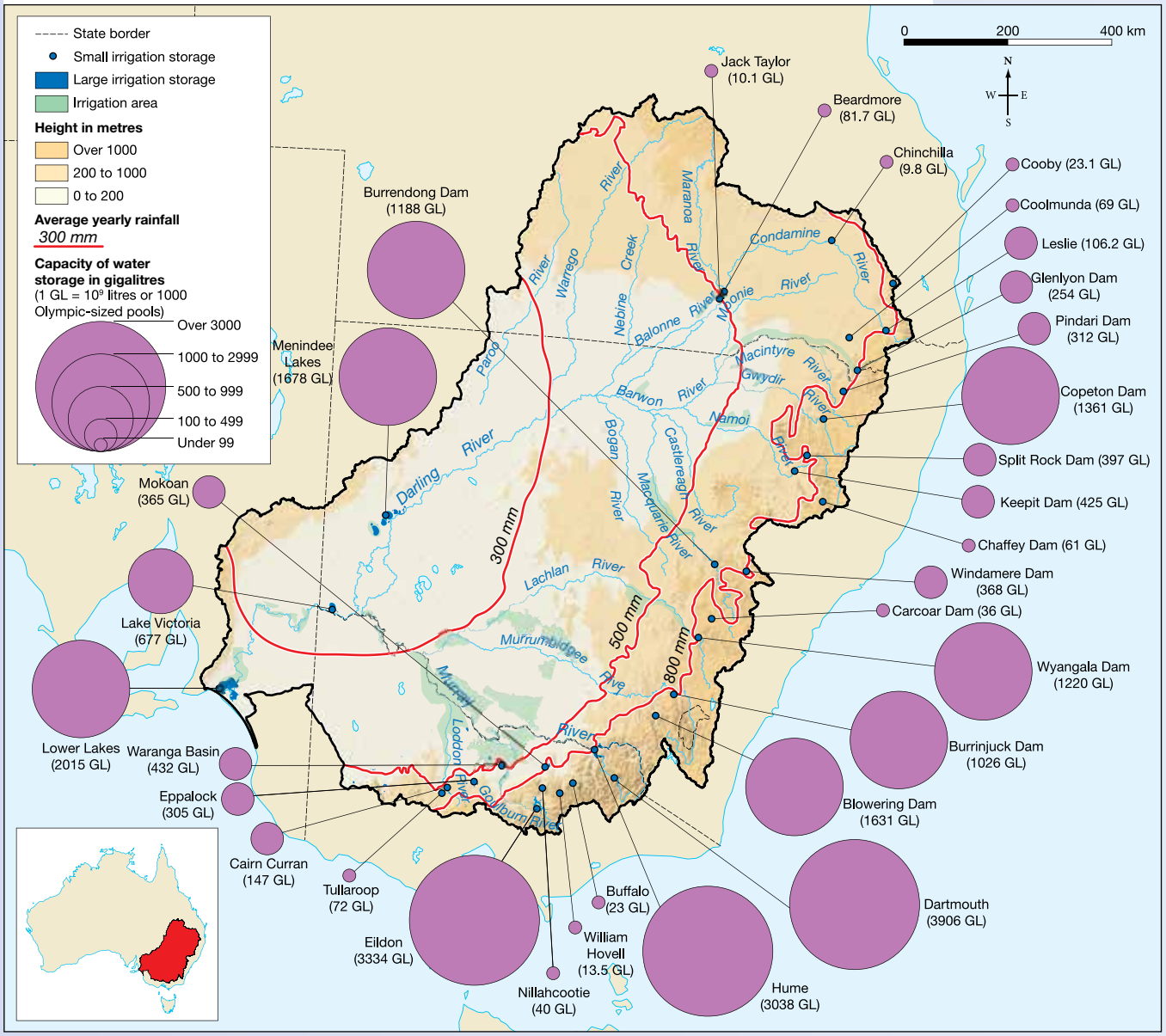
CASE STUDY

Managing water within a country: The Murray–Darling Basin

The Murray–Darling Basin (MDB) is Australia's largest catchment area, covering 14 per cent of the country's total landmass. It stretches across four Australian states (Queensland, New South Wales, Victoria and South Australia) and the Australian Capital Territory, and includes 23 separate river catchments. This is a changed system, in which water is taken out all along its length for storage in dams and use in irrigation. During long periods of drought, little water reaches the Murray mouth, often causing it to close. The Queensland floods in the summers of 2011 and 2012 provided the largest river flows for the MDB in many years.

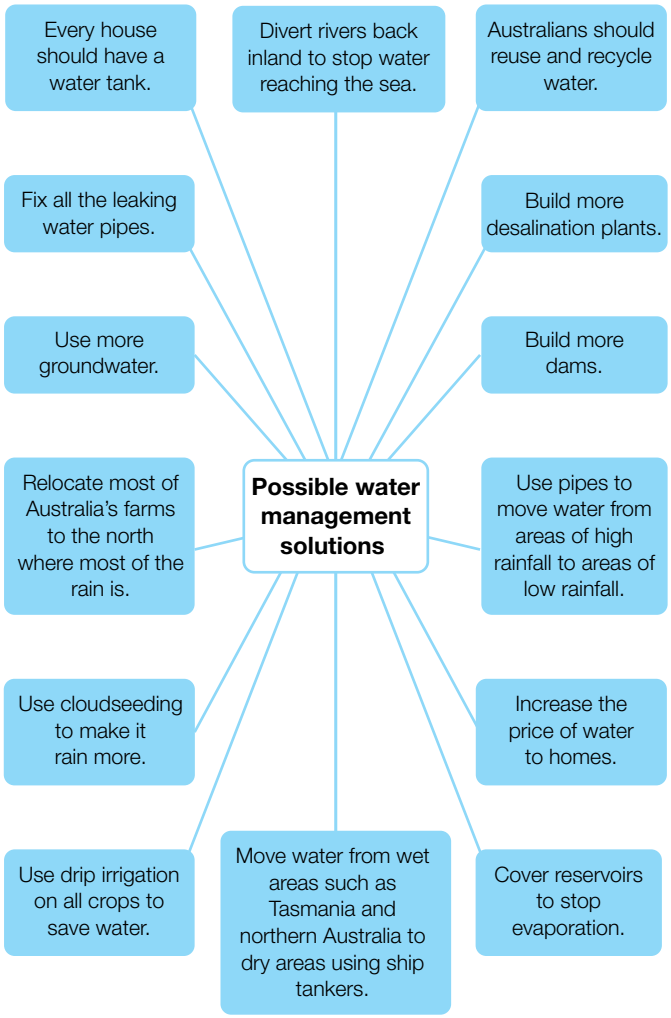
Over the years the management of this river system was the responsibility of each of the four states and the territory, resulting in a lot of conflict. In 2008, the Commonwealth Government took control of the MDB and prepared plans for how it should be managed. There is still controversy over the decisions being made.

FIGURE 3 Map of the Murray–Darling Basin. The Australian Government has been managing the basin.



Source: Spatial Vision

FIGURE 4 Possible water management solutions



Some countries sign international agreements or treaties to try to share water between nations. These include the Rhine and Danube rivers in Europe, the Nile River in north Africa, the Ganges and Brahmaputra rivers in Asia and the Parana River in South America.

Other examples of water basins that are shared by states within a country are the Colorado River and Ogallala Aquifer in the United States, and the Kaveri River in India. The Great Artesian Basin in Australia shares groundwater between Queensland, New South Wales, South Australia and the Northern Territory.

Other water management solutions for Australia

Over recent years, and especially after prolonged droughts, many different solutions have been suggested to solve our water problems. Some of these seem impractical, such as towing icebergs from Antarctica; others have generated much discussion, such as fixing all the leaking pipes in towns, cities and outback bores.

Each of the suggestions has to be considered in light of various factors: cost, impact on people, impact on the environment, technology, and politics.

14.10.2 Managing water use at home

About 50 per cent of household water in Australia is used in the garden. Inside the house, approximately 80 per cent of water used is in the shower, toilet and laundry. It is predicted that our growing Australian population will, by 2051, need nearly twice as much water as we do now.

Policy changes such as water restrictions can reduce water usage. Some restrictions include bans on hosing down driveways, washing cars with hoses and watering private lawns, and cutting back sprinkler use during the day.

The long drought experienced by Australia between about 2003 and 2010 forced many governments to offer rebates on purchases of water-saving products. Items and services included buying and installing water tanks and grey water systems; dual flush toilets; water-saving shower heads and water-efficient washing machines. People were encouraged to spend money on these in order to save water.

FOCUS ON FIELDWORK

Conducting a survey on water management

People in your local community can be a valuable source of information. Surveys are an important fieldwork tool to help you understand the perceptions or feelings of people about a particular issue. Consider what you want to know about water management in your local area. Formulate five questions to ask.

Consider how you will present the information that you collect. If you will want to create graphs, it is advisable to give your respondents options to choose from, such as multiple choices or a Likert scale (for example, a rating from 1 to 5). If you want to write paragraphs explaining your answers then you can leave the questions open — that is, where the answer cannot have a 'yes', 'no' or other singular word answer.

When you have written your survey questions, consider who you will ask and when you will approach them. If you do not feel comfortable approaching people in person, you may choose to use online survey tools and post a link to your survey online or email people directly.

When you have collected your survey data, write a summary of your findings and explain how these findings could inform decisions about water management in your local area.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.

- Salisbury Council — Aquifer storage, transfer and recovery
- Murray–Darling Basin

ACTIVITIES

IDENTIFY

1 Why is it difficult to manage water when the water supply crosses country or state borders?

INVESTIGATE

2 Conduct some further research to find out how water is being managed along the Jordan River in West Asia.

3 Investigate the use of desalination in countries in West Asia (the Middle East). (Refer to the 'Regions' resource in your eBookPLUS.)

4 Watch the video on the Murray–Darling Basin and look at the information on this region in *myWorld Atlas*. Find out about the MDB plan and how it will help manage water.

PREDICT

5 If water were oil, leaking pipes would be fixed immediately. However, there is still a perception that water is not as valuable as oil, so the same investment is not made in it. Imagine you work for an advertising company and have to convince your audience that water is more valuable than oil. Film your advertisement and use a video editing tool to create music and voiceovers. Present this to your class and your school.

APPLY

6 Use the **Catchment detox** weblink in your eBookPLUS to play the catchment-in-crisis game. See if you can manage the catchment so that agricultural, personal, industrial and environmental needs are all met.

What might be the best water solutions for Australia?

7 Study the list of possible water solutions shown in figure 4 and choose the ones that are most likely to work.

You will work in pairs to conduct some research about one of the proposed methods. There will be advantages and disadvantages for each. You will need to use the internet and libraries to find your information, and you will need to find out:

- how the solution will be carried out, including the technology that might be used
- which ***places*** in Australia are most likely to be involved and why (this might include rainfall data, Google images or maps, and photographs)
- how much it will cost and who will pay
- what impact the solution will have on the ***environment***
- what impact there will be on people
- whether there are any political implications
- where the solution will work best (shown on a map).

Presenting your information

Any data collected needs to be presented in an appropriate way. Climate data could be represented as a climate map; a satellite image or photograph could be annotated with notes; models or plans of the solution could be drawn.

Sharing your information

The class will need to share all the information found so that a decision can be made about the most probable solutions. Share via a presentation (such as a Prezi), a class wiki or blog.

Making a decision

Conduct a class vote to remove five of the 14 solutions immediately after the information sharing. Do this by writing each solution on a board and voting on each one. You will be left with nine water management solutions.

Diamond ranking activity

Use the remaining nine solutions to complete a diamond ranking. Make a copy of the nine solutions and write these on separate cards or sticky labels. Individually, use the information you shared about the solutions to rank the solutions from the most viable to the least viable from the top of the chart. It is often easier to work on the two extremes, top and bottom, and then continue working from there.

Once you have your ranking, work in groups of four. Explain why you chose the ranking and see whether each of you can agree on the same ranking. Work together as a class and discuss the solutions again and see if you can arrive at a class ranking.

Conclusion

Write a short report, and include in it the final ranking of water management solutions for Australia. Include the discussions and explanations in your report.

Now write a letter to your local state or territory water authority, outlining what you consider to be the three best management solutions for Australia and why.

8 Conduct a debate on the following statement: There is enough water for all purposes if it is managed well.

eBookplus

Interactivity
Ways forward
Use this interactivity to find out about water use and management solutions around Australia.
Searchlight ID: int-3082

Weblink
Catchment detox

14.11 What are sources of water at Whataroa?

14.11.1 Whataroa region

Whataroa is a town on the northern edge of the South West New Zealand (*Te Wahipounamu*) World Heritage site. It is an area of abundant water and incorporates Fiordland, glaciers and spectacular lakes.

Visitors travel from the town down the Waitangitaona River to view the White Heron Sanctuary, the only breeding area of the white heron (kotuku). Glaciers and snow feed the Whataroa River and its tributaries. The South Westland Maori used the area to hunt birdlife and for fresh-water fishing.



FIGURE 1 Ice on Franz Josef Glacier



FIGURE 2 View of Franz Josef Glacier

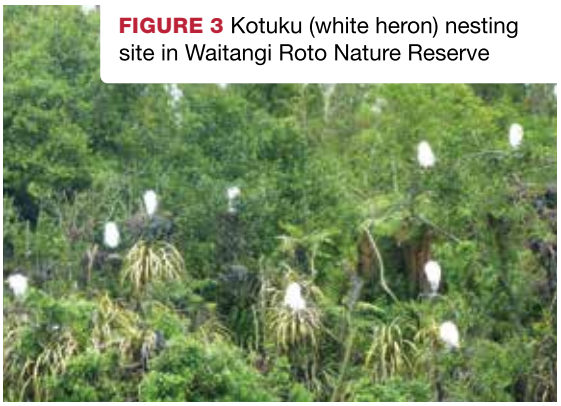


FIGURE 3 Kotuku (white heron) nesting site in Waitangi Roto Nature Reserve

ACTIVITIES

IDENTIFY

1 Examine the north-west quadrant of figure 4. What is the grid reference of:
   - **a** Waitahi Bluff
   - **b** Abut Head
   - **c** Lake Rotokino?

2 What is the direction of:
   - **a** The Forks (AR3720) from Harihari (AR4021)
   - **b** Abut Head (AR 3722) from Whataroa (AR3820)
   - **c** Franz Josef Glacier (AR3718) from Te Taho (AR3921)?

3 What is the height of:
   - **a** Mount Hercules (AR3819)
   - **b** Mount Cloher (AR3819)
   - **c** Drummond Peak (AR3718)
   - **d** Bamford Knob (AR3919)
   - **e** Mount Price (AR3820)?

4 In what direction are the following creeks flowing?
   - **a** Potters Creek (AR3719)
   - **b** Guant Creek (AR3820)
   - **c** Vine Creek (AR3920)
   - **d** Oroko Creek (AR3721)
   - **e** Hughes Creek (AR3919)

EXPLAIN

5 Describe the distribution of swamps in the vicinity of Whataroa. Explain why you think they may be located where they are.

6 Find Franz Josef Glacier in AR3718 and examine the photo in figure 2. Provide a grid reference of where the photographer could have been standing when taking the photograph. Justify your answer.

INVESTIGATE

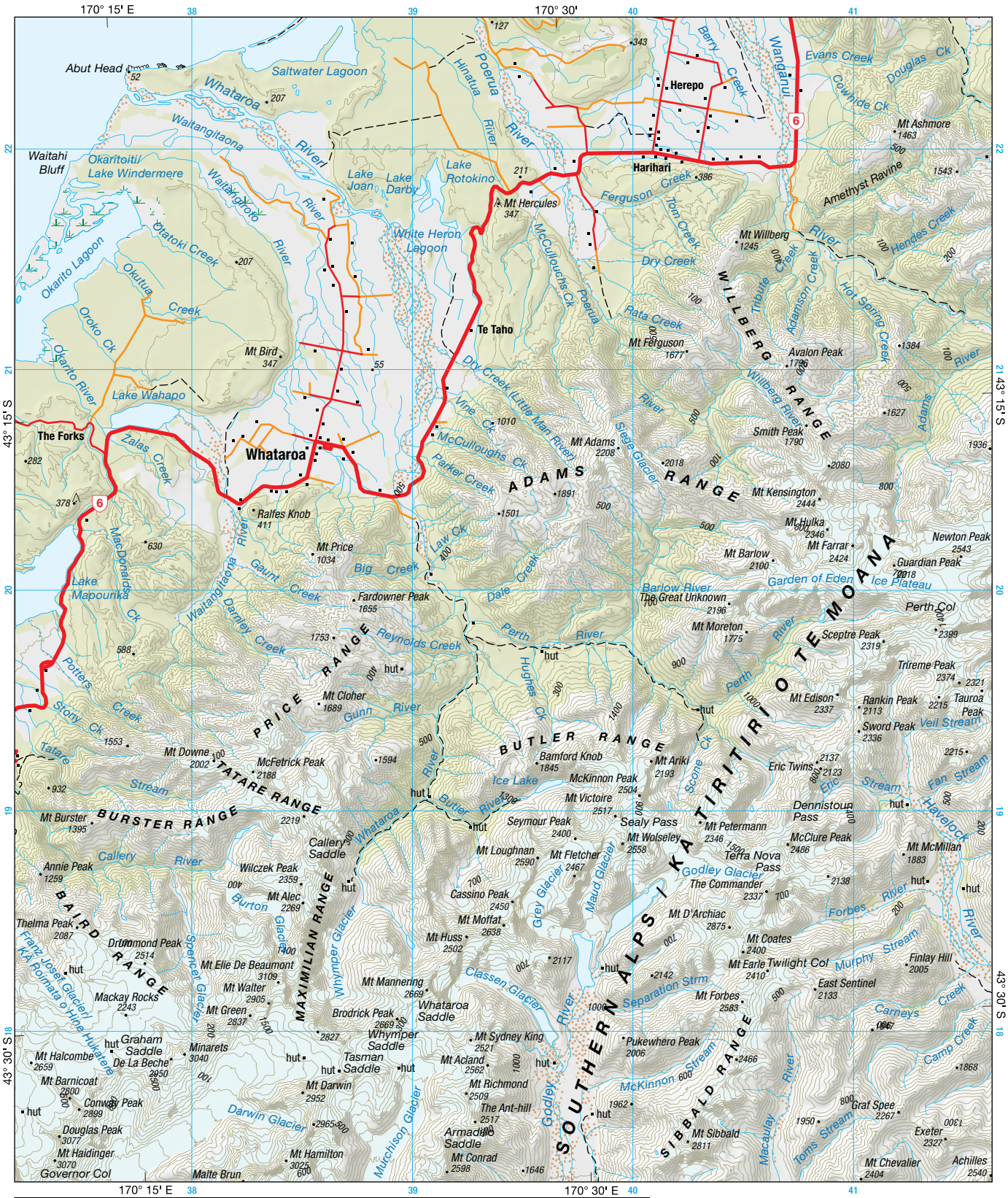
7 Locate White Heron Lagoon. Research the kotuku and the White Heron Sanctuary. Describe why this location would make a suitable breeding ground for the white heron.

eBook*plus* ONLINE ONLY

14.12 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au.**

FIGURE 4 Topographic map of the Whataroa area


170° 15' E
170° 30' E
43° 15' S
43° 30' S
Abut Head
Saltwater Lagoon
Whataroa
Waitangitaona River
Waitahi Bluff
Okaritoiti/ Lake Windermere
Waitangiroto River
Ototoki Creek
Okarito Lagoon
Okutua Creek
Oroko Ck
Okarito River
Lake Wahapo
The Forks
Zalas Creek
Mt Bird
Ralfes Knob
Lake Mapourika
MacDonalds Ck
Potters Ck
Stony Ck
Tatare Stream
Mt Burster
Callery River
Annie Peak
Thelma Peak
Franz Josef Glacier/ Kā Roimata o Hine Hukatere
Mt Halcombe
Mt Barnicoat
Douglas Peak
Mt Haidinger
Governor Col
Malte Brun
Graham Saddle
De La Beche
Minarets
Conway Peak
Darwin Glacier
Mt Hamilton
Hinatua
Poerua River
Lake Joan
Lake Darby
Lake Rotokino
White Heron Lagoon
Mt Hercules
Te Taho
Dry Creek (Little Man River)
Vine Ck
McCulloughs Ck
Parker Creek
Law Ck
Big Creek
Gaunt Creek
Darnley River
Fardowner Peak
Mt Price
Reynolds Creek
Mt Cloher
Gunn River
Mt Downe
McFetrick Peak
Wilczek Peak
Mt Alec
Burton Glacier
Drummond Peak
Mt Elie De Beaumont
Mt Walter
Mackay Rocks
Mt Green
Spencer Glacier
Callery Saddle
Whymper Glacier
Brodrick Peak
Whymper Saddle
Mt Mannering
Whataroa Saddle
Tasman Saddle
Mt Darwin
Mt Sydney King
Mt Acland
Mt Richmond
The Ant-hill
Armadale Saddle
Mt Conrad
Murchison Glacier
Godley Glacier
Herepo
Harihari
Ferguson Creek
Tom Creek
Dry Creek
Rata Creek
Mt Ferguson
Siege Glacier
Mt Adams
Smith Peak
Avalon Peak
Mt Willberg
Wangapeka River
Evans Creek
Douglas Ck
Cowhide Ck
Mt Ashmore
Amethyst Ravine
Hendes Creek
Hot Spring Creek
Adamson Creek
Tributary Creek
Willberg River
Mt Kensington
Mt Hulka
Mt Farrar
Mt Barlow
Newton Peak
Guardian Peak
Garden of Eden Ice Plateau
Barlow River
The Great Unknown
Mt Moreton
Perth Col
Sceptre Peak
Trireme Peak
Mt Edison
Rankin Peak
Tauroa Peak
Sword Peak
Veil Stream
Eric Twins
Eric Stream
Fan Stream
Havelock
Dennistoun Pass
Mt Petermann
Mt Wolseley
Sealy Pass
Terra Nova Pass
McClure Peak
Mt McMillan
Godley Glacier
The Commander
Mt D'Archiac
Mt Coates
Mt Earle
Twilight Col
East Sentinel
Finlay Hill
Forbes River
Murphy Stream
Carneys Creek
Camp Creek
Graf Spee
Exeter
Mt Chevalier
Achilles
Toms Stream
Macaulay River
Separation Strm
McKinnon Stream
Pukewhero Peak
Mt Forbes
Mt Fletcher
Mt Victoire
McKinnon Peak
Bamford Knob
Mt Arikl
Ice Lake
Scone Ck
Hughes Ck
Perth River
Butler River
Gunn River
Seymour Peak
Mt Loughnan
Cassino Peak
Mt Moffat
Mt Huss
Grey Glacier
Maud Glacier
Classen Glacier
Whymper Glacier
Mt Huka
Mt Hulka
Mt Ariki
Mt Sibbald
Pukewhero Peak
Mt Conrad
Mt Hamilton
Mt Darwin
Mt Richmond
Mt Acland
Mt Sydney King
Mt Mannering
Mt Walter
Mt Elie De Beaumont
Mt Moffat
Mt Huss
Mt Fletcher
Mt Victoire
Mt Loughnan
Seymour Peak
Bamford Knob
Mt Ariki
McKinnon Peak
Mt Petermann
Mt Wolseley
Sealy Pass
Terra Nova Pass
Mt D'Archiac
Mt Coates
Mt Earle
Twilight Col
Mt Forbes
Pukewhero Peak
Mt Sibbald
Mt Chevalier
Achilles
Graf Spee
Exeter
Finlay Hill
East Sentinel
Mt McMillan
McClure Peak
Dennistoun Pass
Rankin Peak
Tauroa Peak
Sword Peak
Trireme Peak
Perth Col
Sceptre Peak
Newton Peak
Guardian Peak
Mt Kensington
Mt Farrar
Mt Barlow
Mt Hulka
Mt Willberg
Avalon Peak
Smith Peak
Mt Ferguson
Mt Adams
Mt Ashmore
Herepo
Harihari
Mt Hercules
Te Taho
Whataroa
The Forks
Lake Mapourika
Lake Wahapo
Okarito Lagoon
White Heron Lagoon
Lake Rotokino
Lake Darby
Lake Joan
Waitangiroto River
Waitangitaona River
Hinatua
Poerua River
Wangapeka River
Willberg River
Dry Creek (Little Man River)
McCulloughs Ck
Parker Creek
Law Ck
Big Creek
Gaunt Creek
Darnley River
Reynolds Creek
Hughes Ck
Perth River
Butler River
Gunn River
Callery River
Whataroa River
Ice Lake
Scone Ck
Godley Glacier
Maud Glacier
Grey Glacier
Classen Glacier
Whymper Glacier
Murchison Glacier
Darwin Glacier
Spencer Glacier
Franz Josef Glacier/ Kā Roimata o Hine Hukatere
Separation Strm
McKinnon Stream
Toms Stream
Macaulay River
Forbes River
Murphy Stream
Carneys Creek
Camp Creek
Fan Stream
Eric Stream
Veil Stream
Tatare Stream
Stony Ck
Potters Ck
MacDonalds Ck
Zalas Creek
Okarito River
Okutua Creek
Oroko Ck
Ototoki Creek
Tributary Creek
Adamson Creek
Hot Spring Creek
Hendes Creek
Amethyst Ravine
Cowhide Ck
Douglas Ck
Evans Creek
Berry Creek
Wangapeka River
Willberg River
Ferguson Creek
Tom Creek
Dry Creek
Rata Creek
Siege Glacier
Mt Adams
Smith Peak
Avalon Peak
Mt Willberg
Mt Ferguson
Mt Kensington
Mt Hulka
Mt Farrar
Mt Barlow
Newton Peak
Guardian Peak
Garden of Eden Ice Plateau
Barlow River
The Great Unknown
Mt Moreton
Perth Col
Sceptre Peak
Trireme Peak
Mt Edison
Rankin Peak
Tauroa Peak
Sword Peak
Veil Stream
Eric Twins
Eric Stream
Fan Stream
Havelock
Dennistoun Pass
Mt Petermann
Mt Wolseley
Sealy Pass
Terra Nova Pass
McClure Peak
Mt McMillan
Godley Glacier
The Commander
Mt D'Archiac
Mt Coates
Mt Earle
Twilight Col
East Sentinel
Finlay Hill
Forbes River
Murphy Stream
Carneys Creek
Camp Creek
Graf Spee
Exeter
Mt Chevalier
Achilles
Toms Stream
Macaulay River
Separation Strm
McKinnon Stream
Pukewhero Peak
Mt Forbes
Mt Fletcher
Mt Victoire
McKinnon Peak
Bamford Knob
Mt Ariki

14.6 SkillBuilder: Constructing a pie graph

14.6.1 Tell me

What is a pie graph?

A pie graph, or pie chart, is a graph in which slices or segments represent the size of different parts that make up the whole. The circle of 360 degrees represents the total, or 100 per cent of whatever is being looked at. The size of the segments is easily seen. By presenting the parts in order, from largest to smallest, it is easier to interpret.

A pie graph can be drawn by hand or by using a spreadsheet program.

Why are pie graphs useful?

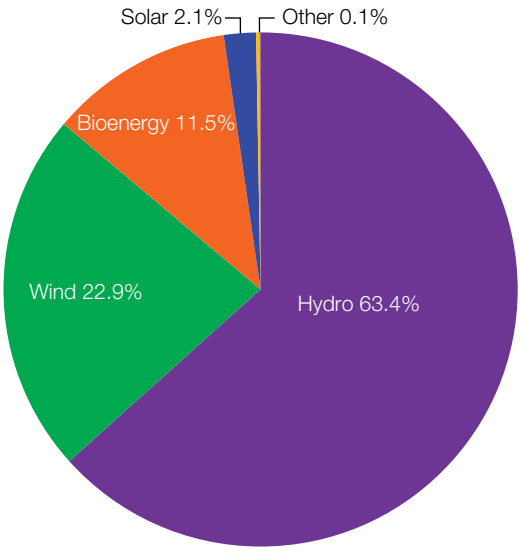
Pie graphs give us an overall impression of data. They are useful for comparing proportions of categories. If there are more than eight segments, the graph becomes difficult to read and it is better to use a bar graph. Unlike line graphs, pie graphs are not useful for showing a trend over time.

Model

A good pie graph:

- has a clear and accurate title that explains the purpose of the graph
- has segments that are either labelled directly or indicated by means of a colour key
- includes percentages or raw figures
- has segments drawn clockwise from largest to smallest, starting at 12 o'clock (top centre) with the largest and finishing at 12 o'clock with the smallest, unless there is 'other', which is always last
- includes the source of the data.

FIGURE 1 Percentage of electricity generated from renewables in Australia by energy source (2010)



Note: 5.2% of total energy consumption in Australia is from renewable sources.

Source: Clean Energy Council, Clean Energy Australia 2010, page 6

14.6.2 Show me

How to complete a pie graph

You will need:

- paper
- a pencil
- a protractor
- a ruler
- coloured pencils
- a data set — in this case, energy generated from renewables in New Zealand (table 1).

TABLE 1 Percentage of electricity generated from renewables in New Zealand by energy source (2010)

Renewable energy	Percentage (%)
Hydro	28
Bioenergy and solar	20
Wind	2
Geothermal	50

Note: In 2011, 77% of all electricity generated in New Zealand came from renewable resources.

Source: New Zealand Energy Data File 2012

eBookplus

eLesson
Completing a pie graph
Searchlight ID: eles-1632

Procedure:

STEP 1

Order the statistics from largest to smallest. If there is an 'other' category, put it last.

STEP 2

If there are raw figures, convert them to percentages. You divide each category by the total figure and multiply by 100.

STEP 3

Convert the percentage to degrees of a circle by multiplying by 3.6. (100 per cent of the circle = 360 degrees, so 1 per cent of the circle = 3.6 degrees.)

STEP 4

Draw a straight line from the centre of the circle to 12 o'clock.

STEP 5

Use the protractor to mark the first and largest segment, working clockwise. To do this, place the 0 degrees line on the protractor along the line you have just drawn. Now mark in the second largest group. Use the protractor to mark each of the other segments in descending size, marking the 'other' category last.

STEP 6

Label and colour each segment, making sure you include the percentage.

STEP 7

Provide a clear title and source.

eBook*plus*

Interactivity
Constructing a pie graph
Searchlight ID: int-3128

14.6.3 Let me do it

Developing my skills

Use the data in table 2 to create a pie graph.

TABLE 2 Source of electricity worldwide, 2010

Source of electricity	Percentage (%)
Coal	42
Oil	5
Natural gas	21
Nuclear	13
Hydro	16
Other	3

Source: Based on data from OECD 2011, *Factbook 2011–2012: Economic, Environmental and Social Statistics,* OECD Publishing, http://dx.doi.org/10.1787/factbook-2011-49-en

Questions

1. What is the most common source to produce electricity?
2. Are renewables or non-renewables the main source of electricity?
3. Name a renewable that is part of the 'other' category.
4. In Iceland 70 per cent of all electricity is produced from hydro-power and 30 per cent is produced from geothermal power. Is this similar or different to the world trend?
5. Research the sources of energy production for another country. Compare your results to Australia and Iceland.

Checklist

I have:

- provided a clear title and source
- plotted the data accurately and labelled each segment
- included the percentages
- drawn segments largest to smallest clockwise from 12 o'clock with 'other' last.

Skills questions

1. To calculate segments for a pie graph, you:
   a. multiply each percentage by 3.6
   b. multiply each percentage by 100
   c. divide each percentage by 3.6
   d. add the percentages together and then divide by 360.
2. Which statement about pie graphs is false?
   a. Stating the source of data enables the reader to think about how reliable the data is.
   b. Segments are drawn in order from largest to smallest, except 'other', which is always last.
   c. A pie graph is useful for showing a trend over time.
   d. A clear title is essential so that the reader can understand the data presented.
3. Explain why drawing a pie graph with 18 segments is not recommended.
4. Why are pie graphs useful?

14.8 SkillBuilder: Reading and describing basic choropleth maps

14.8.1 Tell me

What is a basic choropleth map?

A basic choropleth map is a shaded or coloured map that shows the density or concentration of a particular aspect of an area. The key/legend shows the value of each shading or colouring. The darkest colours show the highest concentration, and the lightest colours show the lowest concentration.

Why are basic choropleth maps useful?

A basic choropleth map is used to show particular aspects in a pictorial way. They allow the viewer to quickly identify where the values are highest (darkest) and lowest (lightest) and note any patterns over space. However, the information is based on averages and precise data is not given for a particular place or region within the map. Areas can contain within them wide variations from the average value mapped. An atlas will have a wide range of choropleth maps.

Basic choropleth maps are useful for showing:

- differences between the highest and lowest concentrations of aspects
- average rainfall across a country
- average population densities per region
- average wealth per country
- average number of cars per household in local council areas.

Model

The population density across Brazil (figure 1) varies considerably from the coast to the inland regions. The population density is greatest (over 100 people per square kilometre) along the Atlantic Ocean coast, especially in the largest cities. For a distance of about 700 kilometres from the coast, the population density is generally around 50 people per square kilometre. The large inland area of Brazil has a low population density of less than 10 people per square kilometre.

A good description of a basic choropleth map is achieved if:

- an overall pattern is described
- the highest concentration is identified
- the lowest concentration is identified
- any anomalies are stated
- quantification is used wherever possible.

14.8.2 Show me

How to read and describe a basic choropleth map

You will need:

- a basic choropleth map.

Procedure:

STEP 1

Read the title of the map to get an impression of what the map is going to show you. Check that the source of the information is a recognised authority. If the source is not stated, check the list of acknowledgements for the textbook to find out where the information came from.

STEP 2

Read the key/legend next. Check the units of measurement that are used. Think about the divisions that are used for colours. The darker the colour, the more intense or higher the value; similarly, the paler the colour, the less intense or lower the value. Cast your eye over the map, taking in the colours and trying to work out any general patterns that emerge.

eBookplus
eLesson
Reading and describing basic choropleth maps
Searchlight ID: eles-1706

FIGURE 1 Population density in Brazil



Source: MAPgraphics Pty Ltd, Brisbane

STEP 3

To interpret the colours, you need to comment on where the darkest colours or the more intense/higher values occur. Can you discuss the map by continent, or by region? For example, the highest density of people in Brazil occurs in the cities, such as São Paulo and Fortaleza, on the Atlantic Ocean coastline.

STEP 4

To further interpret the colours, you need to comment on where the lightest colours or the least intense/lower values occur. Can you discuss the map by continent, or by region? For example, the lowest density of people in Brazil occurs in the large inland region, especially along and around the Amazon River and its tributaries.

eBook*plus*

Interactivity
Reading and describing basic choropleth maps
Searchlight ID: int-3286

STEP 5

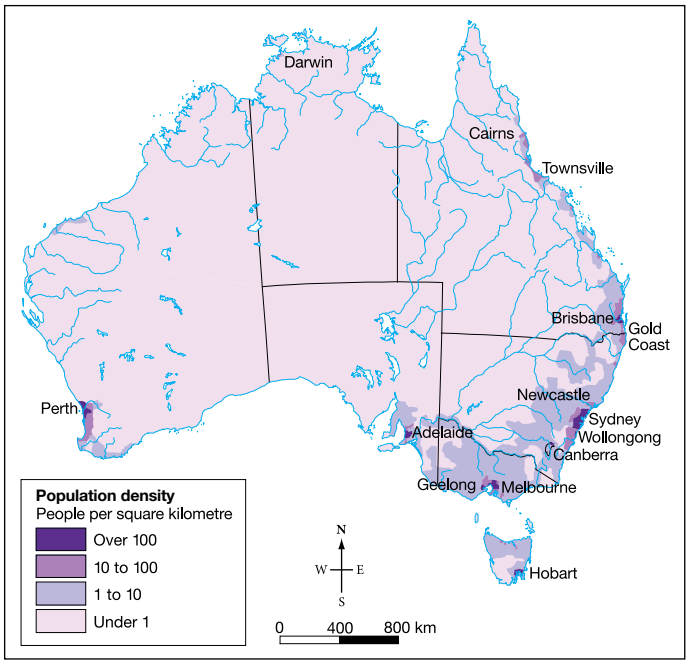
Are there any coloured areas that stand out from the rest as being unusual? That is, is there a colour among a mass of other colour that isn't expected? This is referred to as an anomaly, and needs to be discussed. Identify the place that is different from the surrounding area. For example, the population densities around Brasilia and Goiania are unusual as these appear to be isolated clusters of higher population, whereas most of the area contains fewer than 10 people per square kilometre.

14.8.3 Let me do it

Developing my skills

Read and interpret figure 2, showing a basic choropleth map of Australia's population density, and then answer the following questions.

FIGURE 2 Australia's population distribution and density



Source: MAPgraphics Pty Ltd, Brisbane.

Questions

1. Which region(s) of Australia have a pattern indicating the highest population density? Provide statistics or numbers (quantification) in your answer, such as percentage (%), size or area (square kilometres, km^2).
2. Which region(s) of Australia have a pattern indicating the lowest population density? Include quantification in your answer.
3. Are there any places that do not fit the expected pattern? State the locations of these anomalies.
4. Which Australian state is most densely populated?
5. Give two reasons that large parts of Australia have a low population density.

Checklist

I have:

- described an overall pattern
- identified the highest concentration
- identified the lowest concentration
- stated any anomalies
- used quantification wherever possible.

Skills questions

1. Basic choropleth maps are used to show:
   a. the height of the land across a region
   b. a range of colours
   c. the distribution of one factor
   d. the distribution of many factors.

2. A basic choropleth map includes information about:
   a. numbers
   b. colours
   c. species
   d. ground cover.
3. Why do you give a general summary of the map first?
4. Why do you identify any anomalies?

14.12 Review

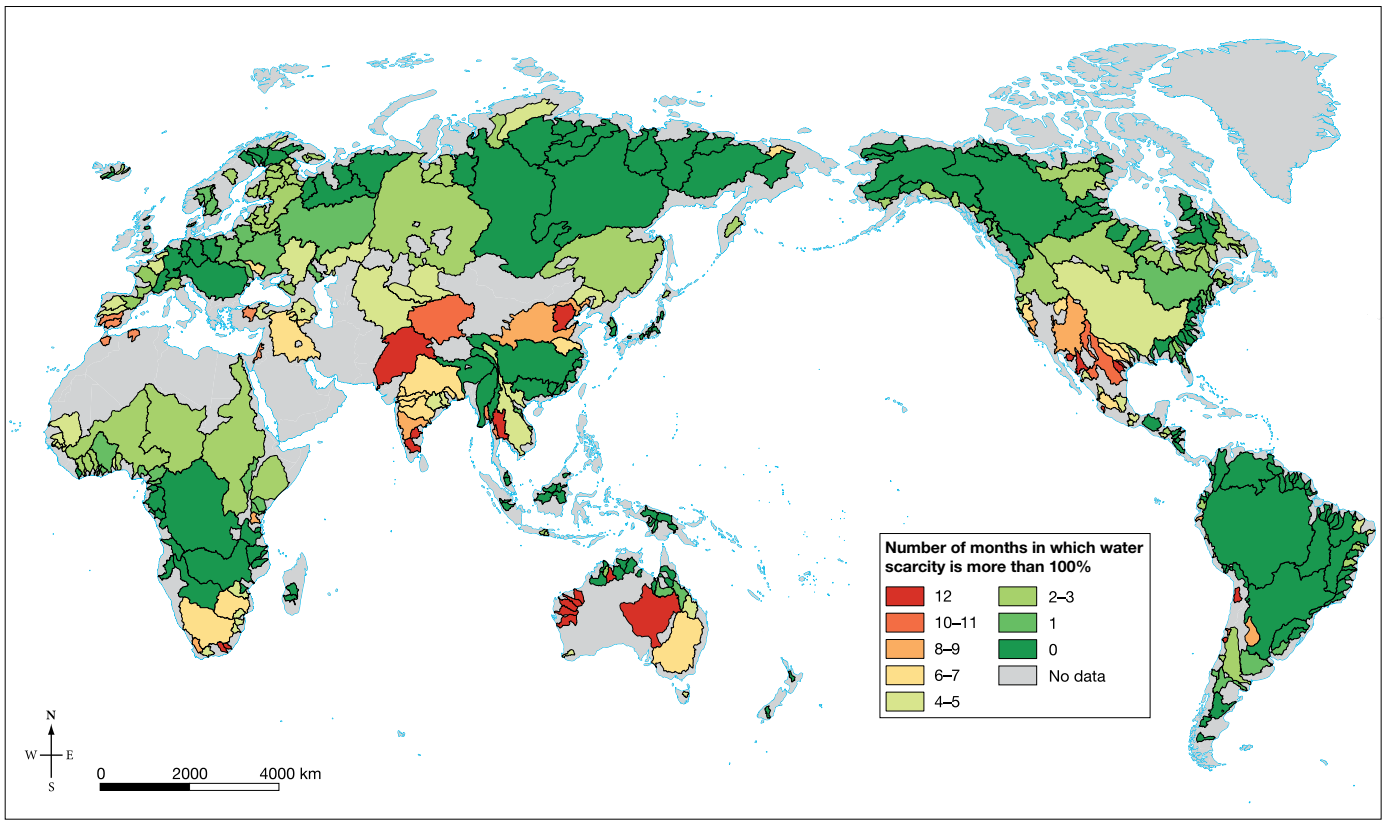
14.12.1 Review

1. How do rainfall and run-off contribute to the amount of water Australia has to use?
2. List the three most interesting water facts you have learned about in this chapter.
3. What is the difference between water scarcity and water stress? Name three countries, each from a different continent, facing water stress.
4. Explain how water scarcity can affect women in different ways to men.
5. Water has been described as one of the biggest issues facing the world. Do you agree with this? Use examples from this chapter to justify your view.
6. Describe how governments and non-government organisations attempt to address water scarcity.
7. Explain how political borders can make it difficult to manage water effectively.
8. Explain some of the difficulties in managing the Murray–Darling basin.

14.12.2 Reflect

9. Study the map in figure 1. Note that when referring to global water scarcity, a scarcity of 100 per cent means that all the available blue water has been consumed.

FIGURE 1 Global population with access to drinking water



Source: Hoekstra, A.Y. and Mekonnen, M.M. 2011, 'Global water scarcity: monthly blue water footprint compared to blue water availability for the world's major river basins', Value of Water Research Report Series No. 53, UNESCO-IHE, Delft, the Netherlands

a. Name two regions that experienced the greatest water scarcity.
b. Name three regions that did not suffer water scarcity. How do you account for this? Use an atlas map of rainfall to help you.
c. Describe the relationship between water scarcity and rainfall. What other factors increase water scarcity?



Wind farm in a storm: the positive power of the wind

CHAPTER 15

Too much wind, too much water

15.1 Overview

15.1.1 Introduction

People have long harnessed the power of the wind and water for energy. We harness them to produce electricity around the globe. But strong winds and water flow can also cause great destruction, especially when accompanied by heavy rain. These winds can tear roofs from houses and pull trees from the ground.

Starter questions

1 **a** What areas at your school are exposed to wind and where are the more sheltered spots?
  b How is wind shown in the image on this page?
2 List as many examples as you can of the way the wind influences you. Include positive and negative influences.
3 As a class, brainstorm a list of extreme weather events related to the wind and water.
4 Have you ever experienced an extreme weather event? Describe how it made you feel.

Inquiry sequence

		Syllabus outcomes
15.1 Overview		
15.2 How is a natural hazard different from a natural disaster?		GE4-1
15.3 SkillBuilder: Cardinal points: wind roses	eBookplus ONLINE ONLY	GE4-7
15.4 Why does it flood?		GE4-2, GE4-3, GE4-5
15.5 What are the impacts of floods?		GE4-2, GE4-3, GE4-5
15.6 SkillBuilder: Creating a simple column or bar graph	eBookplus ONLINE ONLY	
15.7 How do places around the world manage floods?		GE4-5
15.8 How do tornadoes impact people and environments?		GE4-2, GE4-3, GE4-5
15.9 What was the impact of the May 2013 tornado in the United States?	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-5
15.10 What is a cyclone?		GE4-5, GE4-7
15.11 What impact did Cyclone Yasi have?	eBookplus ONLINE ONLY	GE4-5, GE4-7
15.12 What are the impacts of typhoons in Asia?		GE4-5
15.13 How do we respond to extreme weather and water events?		GE4-5
15.14 How do we manage extreme weather and water events?		GE4-5
15.15 Investigating topographic maps: How does flooding affect the Narrabeen lagoon?		GE4-5
15.16 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Wind hazards
Searchlight ID: eles-1618

15.2 How is a natural hazard different from a natural disaster?

natural hazard an extreme event that is the result of natural processes and has the potential to cause serious material damage and loss of life

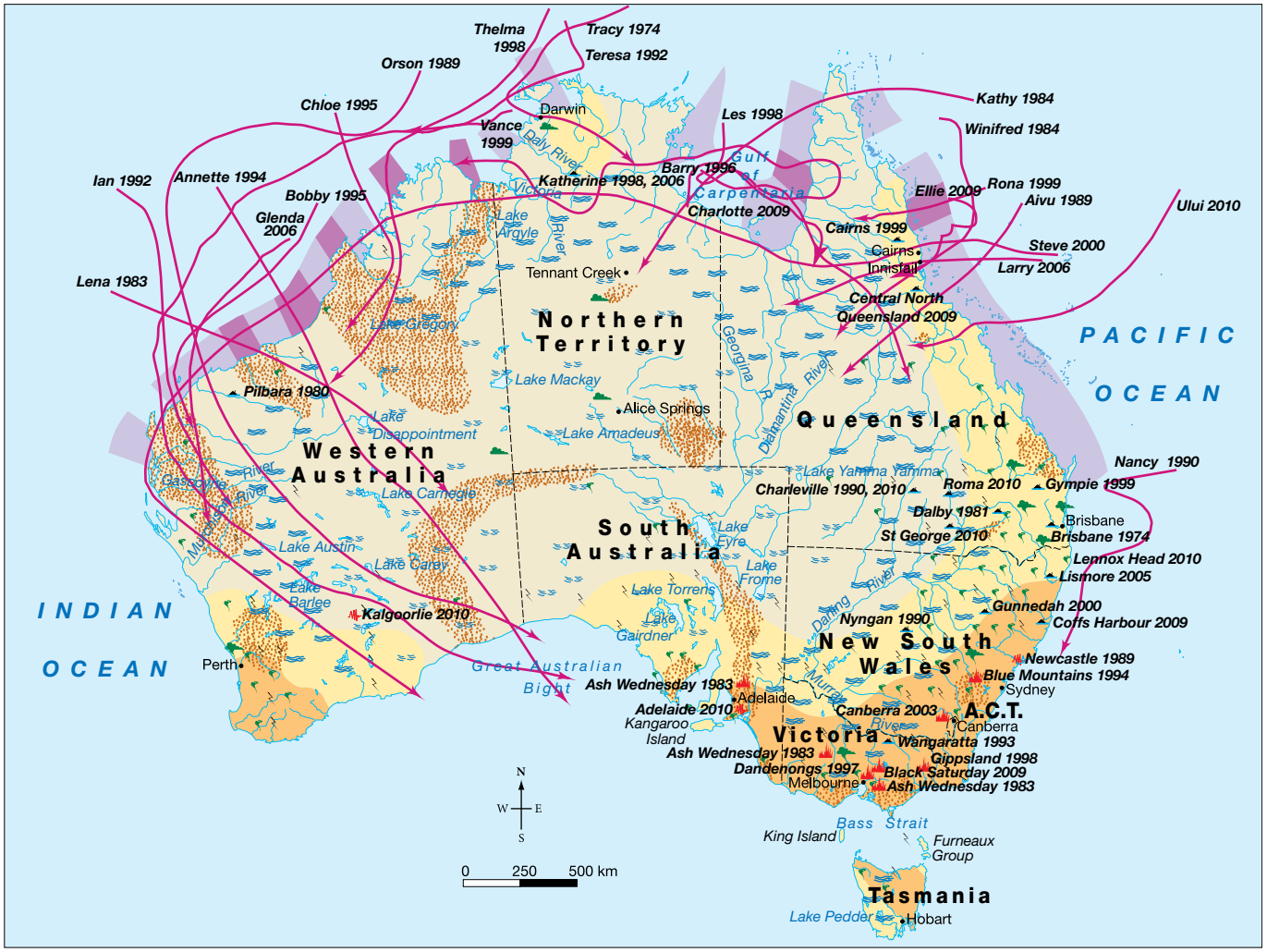
natural disaster an extreme event that is the result of natural processes and causes serious material damage or loss of life

15.2.1 Natural hazards

Australia is prone to a wide variety of natural hazards, which range from drought and bushfire to flooding. Many of these events are part of the weather's natural cycle. However, human actions such as overgrazing, deforestation and the alteration of natural waterways have sometimes increased the impact of these hazards.

A **natural hazard** is an event that is a *potential* source of harm to a community. It is the result of natural processes and may cause serious damage to buildings, roads, communication, transport and loss of life. In contrast, a **natural disaster** occurs as a result of a hazardous event that dramatically affects a community.

FIGURE 1 Australia's natural hazards and disasters

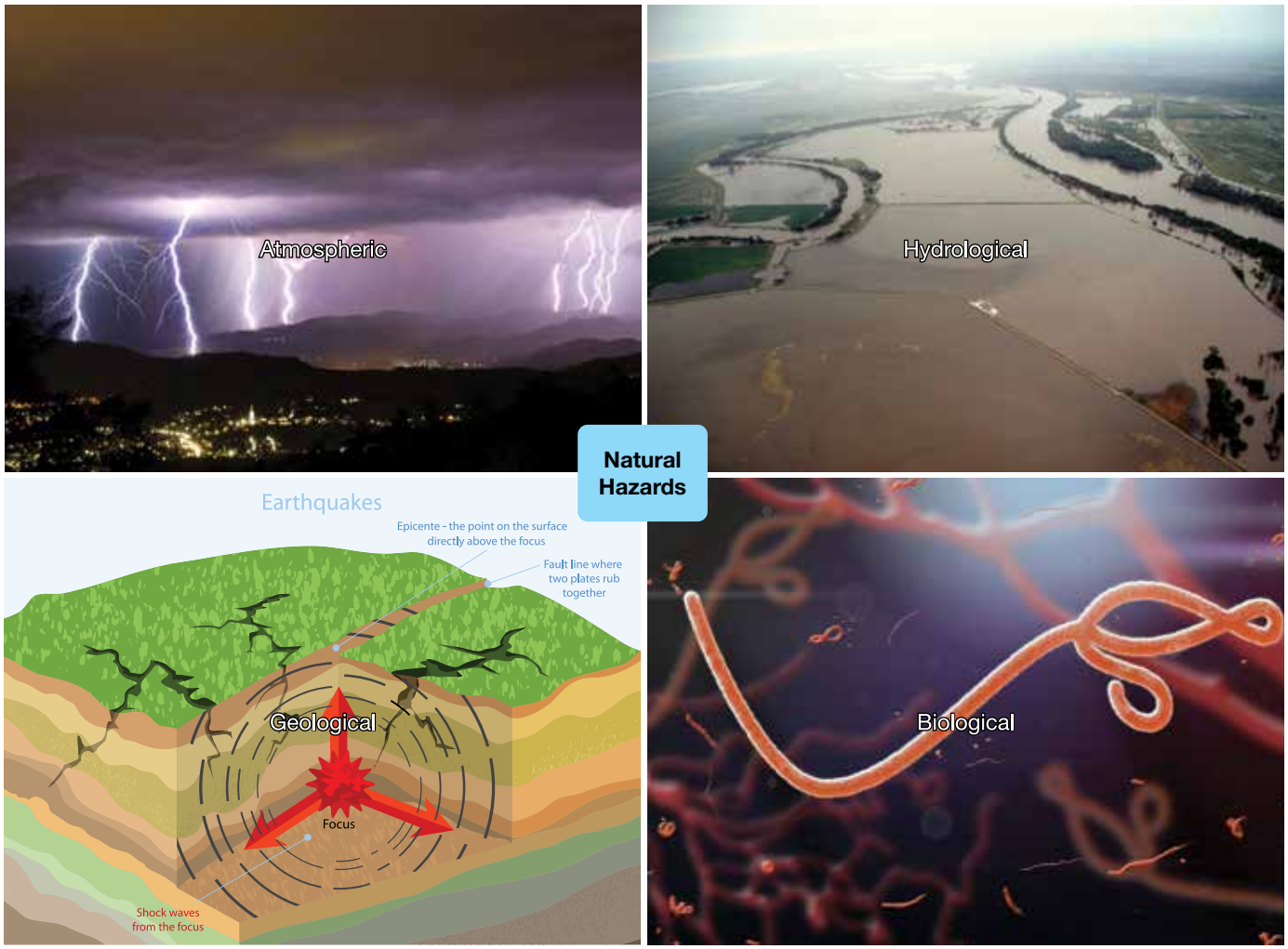


Source: MAPgraphics Pty Ltd, Brisbane

Atmospheric and hydrologic hazards

The four broad types of natural hazards are:
1. **atmospheric** — for example, cyclones, hailstorms, blizzards and bushfires
2. **hydrological** — for example, flooding, wave action and glaciers
3. **geological** — for example, earthquakes and volcanoes
4. **biological** — for example, disease epidemics and plagues.

FIGURE 2 The four types of natural hazards



Natural hazards that are closely linked to the weather are categorised into atmospheric and hydrologic types. Some natural hazards are influenced by the actions of people and where they choose to locate built-up areas. After a period of sustained rainfall, a flood may occur in low-lying areas. Humans can influence the severity of a flood by building on floodplains and not planning for a potential disaster.

15.2.2 Impacts of a natural disaster

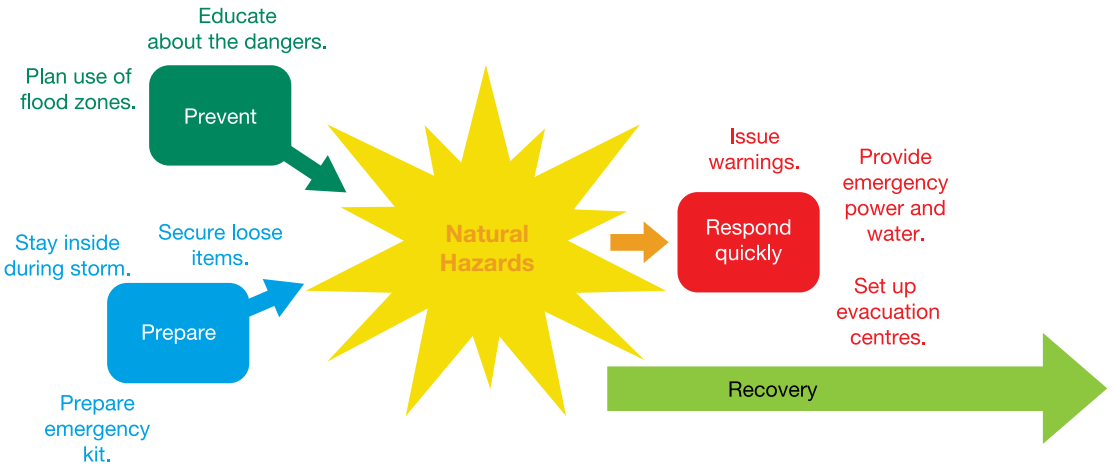
A variety of atmospheric and hydrologic hazards occur around the world. Some places tend to experience particular types of hazards more frequently than other locations. Figure 1 shows that different types of hazards are more likely to occur in different parts of Australia. For example, areas of northern Australia are more **vulnerable** to the threat of tropical cyclones. The communities living in these parts have decided that the benefits of living there outweigh the risk of natural hazards. The ability of an area to recover from the impact of a natural hazard may be hampered by a lack of resources. People may lose their personal belongings, homes and livestock which are often linked to their incomes. However, in regions that are adequately prepared, and where there is support to cope and rebuild, people recover more quickly.

vulnerable the state of being without protection and open to harm

15.2.3 Responding to natural hazards

When hazardous events take place in populated areas, a disaster can occur more easily. Action that is designed to prepare, prevent and respond quickly and that involves individuals, groups and the government allows recovery to occur more effectively (see figure 3).

FIGURE 3 Strategies to respond to natural hazards

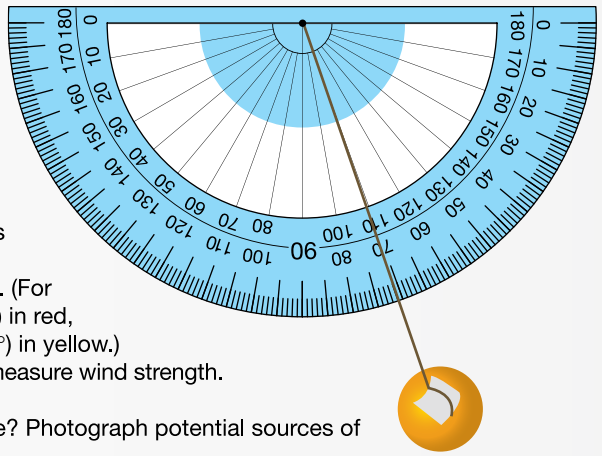


GEOskills TOOLBOX

Measuring wind speed

A wind rose is a visual way to show wind direction. It is a record of the number of times that the wind being measured blows from a particular direction. It is important to remember that wind is named by the direction it blows *from*.

FIGURE 4 An instrument to measure wind strength



1 a Design and create an instrument to measure wind strength. (This could be a length of ribbon about 30 centimetres long held above your head or a ping-pong ball threaded onto string and taped to a protractor.)
b Create a simple plan of the school or your home. Select four sites based on the amount of open space to compare wind strength.
c Create a 'wind scale' for use in the field to indicate wind strength. (For instance, mark your wind scale by indicating strong wind (0°–30°) in red, medium-strength wind (30°–60°) in orange, and a breeze (60°–90°) in yellow.)

2 On a windy day, in small groups, visit each of the selected points to measure wind strength.
a Apply your 'wind scale' at each location and shade the area.
b Imagine extreme wind conditions. What hazards exist at each site? Photograph potential sources of harm in strong winds.

3 Compare two of the sites investigated using specific reference to your wind scale and the images of potential hazards.

ACTIVITIES

IDENTIFY

1 How do natural hazards and natural disasters differ?

EXPLAIN

2 Explain how a flood is both a natural and human hazard.
3 Explain why the risk of experiencing a natural disaster depends on the geographical location of a community.
4 Describe key ***changes*** that natural hazards and natural disasters can cause to an ***environment***.

APPLY

5 Refer to figure 1.
a What types of natural disasters occur most often in Australia?
b Describe the location of Australia's cyclone hazard zone.
c Give one example of a community that has suffered a bushfire disaster.
d What type of hazards are communities around Newcastle subject to?
e What would be the likely impact of a large earthquake occurring in the earthquake risk area in the Northern Territory?

6 Investigate the ways a natural hazard has created challenges for heavily populated areas.

eBookplus

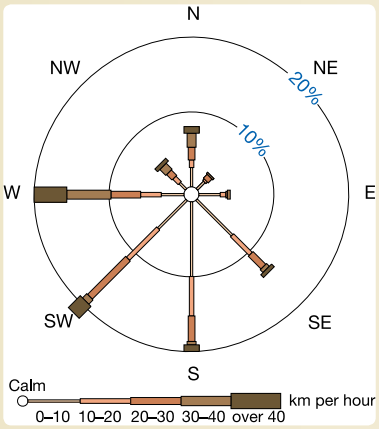
Interactivity
Hotspot Commander: natural hazards
Use this interactivity to explore Australia's natural hazards.
Searchlight ID: int-3083

eBook*plus*
ONLINE ONLY

15.3 SkillBuilder: Cardinal points: wind rose

What are wind roses?

A wind rose is a diagram that shows the main wind features of a place, in particular wind direction, speed and frequency. Wind directions can be divided into eight or sixteen compass directions.



eLesson

Watch this video to learn how to interpret wind roses.



Searchlight ID: eles-1638

Interactivity

Try this interactivity to learn how to interpret wind roses.



Searchlight ID: int-3134

15.4 Why does it flood?

15.4.1 Why does it flood?

Even though Australia is the driest of all the world's inhabited continents, there are periods of very heavy rainfall and **flood**. Flood disasters in Australia damage property, kill livestock, and cause the loss of human life. Since 1788 more than 2000 people have died in floods, equalling the number of deaths from cyclones. In some cases, entire sections of a town have been washed away, as in 1852, when one-third of the town of Gundagai disappeared.

flood inundation by water, usually when a river overflows its banks and covers surrounding land

Floods are an unusual accumulation of water that overflows from rivers, lakes or the ocean onto land that is not normally covered by water. The flooding can be caused by a number of factors including storms, and low pressure systems such as cyclones, typhoons and hurricanes. Heavy rainfall during storms can lead to a rapid rise in water level over a very short period of time. This is known as flash flooding. The water is unable to soak into the ground quickly, and so it runs down to the river and rushes towards the sea. Fast-moving floodwater (figure 1) causes great risk to property and human life because there is less time to prepare. Riverine flooding (figure 2) occurs when the rivers burst their banks and cover the surrounding land. It is a relatively slower process and may isolate communities for many weeks. There are other forms of flooding including those caused by storm surges and tsunamis that lead to seawater flooding.

FIGURE 1 Flash flood in Toowoomba, Queensland, 2011



FIGURE 2 Damage left in Toowoomba after the flash flood



15.4.2 Floods and floodplains

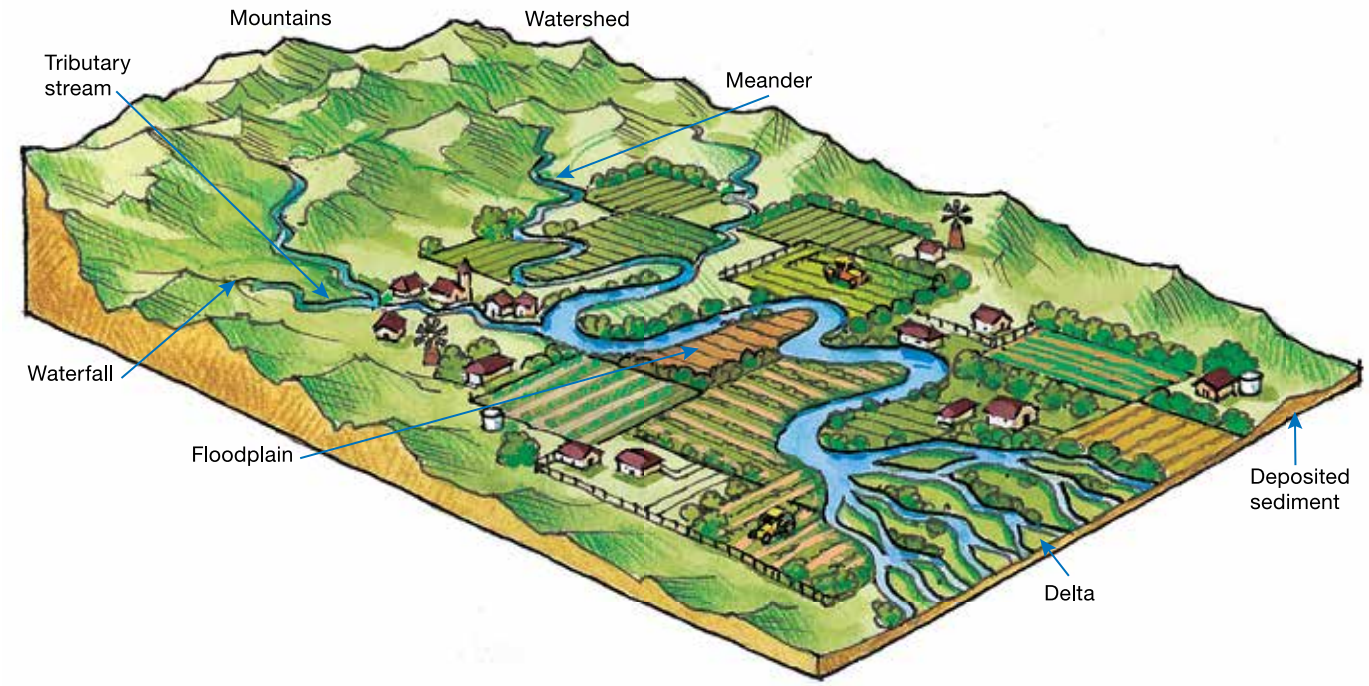
Floods are a natural occurrence, but they are a natural hazard to humans, who tend to build farms, towns and transport routes in areas such as floodplains. A floodplain (figure 3) is an area of relatively flat land that borders a river and is covered by water during a flood. Floodplains are formed when the water in a river slows down in flat areas. The river begins to meander and gradually deposits **alluvium**, which builds up the floodplain and other landforms such as deltas.

alluvium the loose material brought down by a river and deposited on its bed, or on the floodplain or delta

These fertile, flat areas are used for farming and settlement around the world. In Australia, many of our richest farmlands are on floodplains, and towns are often built on them, close to rivers. Such towns are subject to flooding. The possibility of flood is also increased when vegetation in **catchment areas** has been cleared or modified. Native vegetation can slow down run-off and reduce the chance of flooding.

catchment area the area of land that contributes water to a river and its tributaries

FIGURE 3 Flat, fertile floodplains are often preferred areas for settlement and farming.



15.4.3 La Niña and floods

A La Niña event in Australia is often associated with floods. La Niña is virtually the opposite of El Niño. Very cold waters dominate the eastern Pacific, and the oceans off Australia are warmer than normal. Large areas of low pressure extend over much of Australia; warm, moist air moves in, and above-average rainfall occurs. There can also be torrential rain and widespread floods.

La Niña events in Australia occurred in 2010–2011, when many parts of Queensland, New South Wales and Victoria were flooded (figure 4).

FIGURE 4 Rockhampton, Queensland, (a) before and (b) during the 2011 flood



ACTIVITIES

IDENTIFY

1 What is a flood?
2 What is a floodplain?

EXPLAIN

3 Why is alluvium important to agriculture?
4 Construct a simple flow diagram to show the process of a La Niña event (see section 15.4.3).

PREDICT

5 Should people continue to build on floodplains? Why or why not? Create a poster that will warn people about the consequences if they continue to develop on floodplain regions.

APPLY

6 Why do floods occur on floodplains and in deltas?
7 Create an overlay map to show the distribution of water in the aerial photos of Rockhampton before and after the 2011 flood. Estimate the percentage of the area covered in both maps. (See Skillbuilder 10.12 'Creating and analysing overlay maps' in your eBookPLUS.) Describe the ***changes*** to the ***environment***.
8 How might the effects of floods in urban ***spaces*** differ from effects in rural ***spaces***?

15.5 What are the impacts of floods?

15.5.1 Impacts of flooding

The impact of flooding will depend on a number of factors including steps taken to prepare, prevent and respond quickly to the event. The disruption flooding causes to an environment and space can be extensive and recovery can take many years.

When the Brisbane River broke its banks on 11 January 2011, many residents were shocked by the devastation left in its wake. Across the world in Brazil, devastating floodwaters were also having a huge impact on the people and the land.

CASE STUDY 1

Queensland, Australia, 2010–2011

Country background

Australia is considered a developed nation with a strong economy. Australians earn on average $38 200 per person. Approximately 22.3 million people reside in Australia, with 4.6 million of those living in Queensland. About 84 per cent of all Australians are located within 50 kilometres of the coast.

Why?

The flooding that affected this region was due to a strong La Niña event. Long periods of heavy rain over Queensland catchments caused rivers to burst their banks.

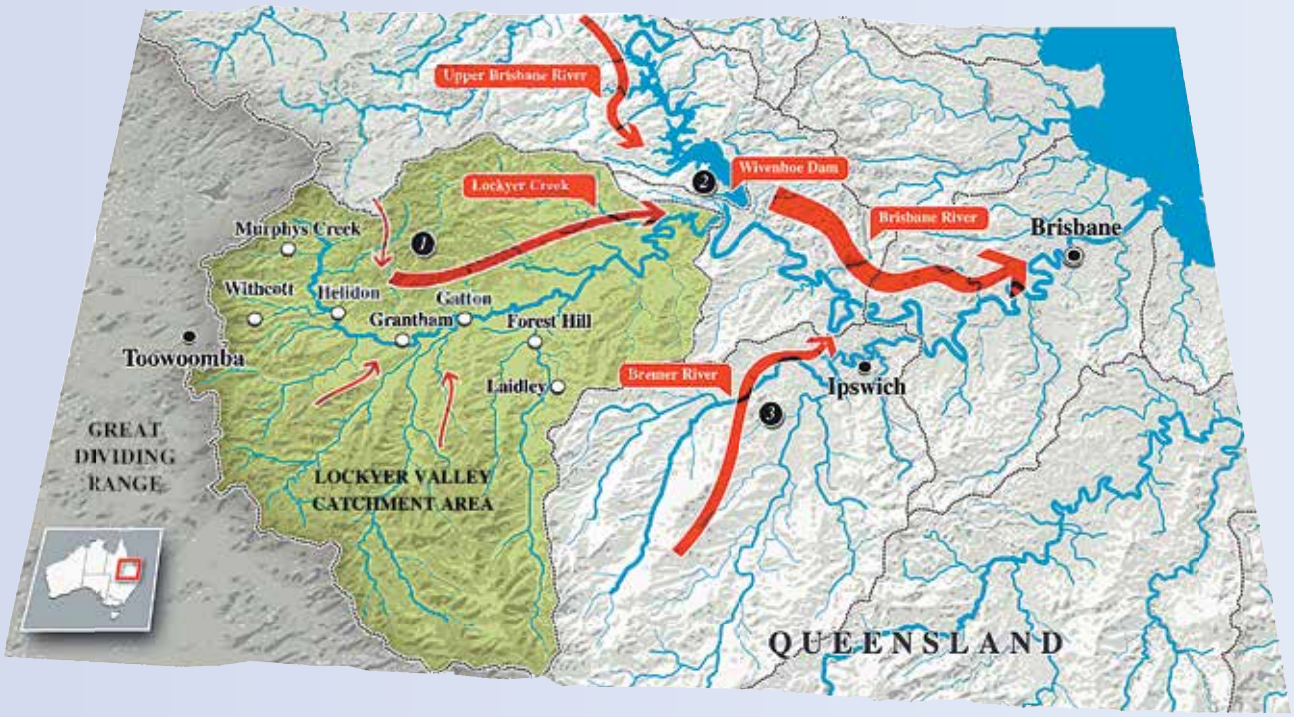
Impacts

- Three-quarters of the state was declared a disaster zone.
- At least 70 towns and over 200 000 people were affected.
- There were 35 deaths.
- Cost to the Australian economy is estimated at least $10 billion.
- Up to 300 roads were closed, including nine major highways.
- Over 20 000 homes were flooded in Brisbane alone.
- There was massive damage and loss of property.

Assistance and recovery

- $1.725 billion is being raised by the Federal Government via a flood levy in the tax system.
- $281.5 million is in the Disaster Relief Appeal set up by the then Premier, Anna Bligh.
- Over $20 million was donated to aid agencies such as the St Vincent de Paul Society to help those suffering.
- About $1.2 million was raised through charity sporting events such as Rally for Relief, Legends of Origin and Twenty20 cricket.
- The Australian Defence Force was mobilised to help with the clean-up.
- The Mud Army was formed: 55 000 volunteers registered to help clean up the streets, and thousands more unregistered people joined them.
- Improvements will be made to dam manuals to help manage the release of water from dams during floods.

FIGURE 1 Anatomy of a flood



Town heights above sea level in metres: Toowoomba 700 m Murphys Creek 704 m Withcott 262 m Helidon 143 m Grantham 110 m Gatton 111 m Forest Hill 95 m Laidley 135 m Ipswich 54.8 m Brisbane 28.4 m

1. Floodwaters from **Lockyer Creek**, which flows into **Brisbane River.** The Lockyer Valley was hit by more than 200 mm of rain.
2. More than 490 000 million litres were released from **Wivenhoe Dam** into Brisbane River.
3. Floodwaters from the **Bremer River**, which is also fed by the **Lockyer Valley.** After passing Ipswich, where it burst its banks, the Bremer flows into the Brisbane River.

CASE STUDY 2

State of Rio de Janeiro, Brazil, 2011

Country background

Brazil is considered a developing nation. Brazilians earn on average $10 200 per person per year. Approximately 198 million people reside in Brazil, with 650 000 living in the three towns worst affected by the flooding.

Why?

Due to the equivalent of a month's rain falling in 24 hours, flash flooding occurred in a mountainous region in Rio de Janeiro State and Sao Paulo State. Hillsides and riverbanks collapsed due to landslides. It is believed that illegal construction and deforestation may have contributed to the instability of the land.

Impacts

- Approximately 900 people died — most of them in poverty-stricken areas with poor housing conditions and no building policies.
- Forty per cent of the vegetable supply for the city of Rio de Janeiro was destroyed.
- Around 17 000 people were left homeless.
- There was widespread property damage, most of it to homes built riskily at the base of steep hills.

Assistance and recovery

- $460 million was set aside by the President for emergency aid and reconstruction.
- Troops were deployed to help.
- There were donations of clothes and food to the area from other Brazilians.
- About $450 million was lent by the World Bank.
- Support was given by internal and international charities.

FIGURE 2 Areas affected by the floods in Brazil, 13 January 2011



Source: Spatial Vision

FIGURE 3 Hills collapsed after the heavy rains, destroying homes.



ACTIVITIES

IDENTIFY

1 When did the floods in Queensland and Brazil occur?

EXPLAIN

2 a Explain, in your own words, the three causes of the Brisbane floods.
b Explain the causes of the Brazilian floods.
c Compare the causes of these two floods by identifying the similarities and differences between them.

3 a Compare the ***scale*** of these floods.
b Give reasons for the differences in the ***scale*** of these floods.

4 In a table, classify (in point form) the impacts on people, the economy and the ***environment*** of the Brisbane and Brazilian floods.

5 Why do you think the impacts differed?

6 How were the responses to the floods in Brisbane and Brazil similar? How and why do you think they were different?

PREDICT

7 Suggest a few strategies that could be implemented to lessen the impact of floods if they occurred in these regions again.

APPLY

8 Imagine you had to evacuate your home because it was under threat from a flood. What five things would you take with you, and why?

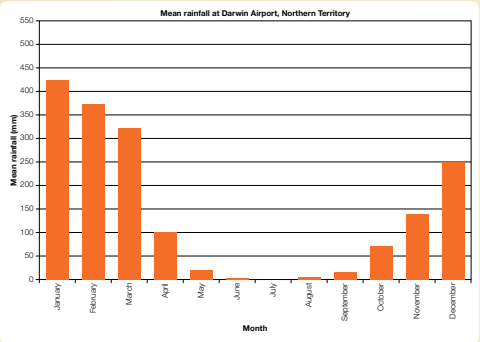
9 Describe the ***interconnection*** between Brisbane and the areas to its west in relation to the January 2011 Brisbane flood.

eBook*plus* ONLINE ONLY

15.6 SkillBuilder: Creating a simple column or bar graph

What are column or bar graphs?

Column graphs show information or data in columns. In a bar graph the bars are drawn horizontally and in column graphs they are drawn vertically. They can be hand drawn or constructed using computer spreadsheets.



Source: Bureau of Meteorology

eLesson

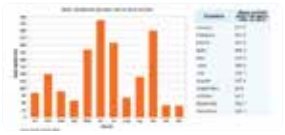
Watch this video to learn how to create a simple column or bar graph.



Searchlight ID: eles-1639

Interactivity

Try this interactivity to learn how to create a simple column or bar graph



Searchlight ID: int-3135

15.7 How do places around the world manage floods?

15.7.1 Managing floods

Floods occur in many countries around the world. It is important for these countries to learn how to effectively live with this natural hazard. Managing the effects of floods is important if the amount of damage caused is to be minimised. Unfortunately, not all countries have the same resources to tackle this problem. Those countries that are able to invest in flood-prevention **infrastructure** have a greater chance of reducing the risk of flood.

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communications systems, water and power lines

The most common form of flood management is to build a barrier that prevents excess water from reaching areas that would suffer major damage. Levees (see figure 2), **weirs** and dams are a few examples of structures that are built to contain floodwaters. Dams that are used to stop flooding need to be kept below a certain level to allow space for floodwater to fill. Wivenhoe Dam in south-east Queensland was built in response to the floods in 1974 (see figure 1). However, there was some debate about whether this dam could have been used more effectively during the 2010–2011 floods.

weir a barrier across a river, similar to a dam, which causes water to pool behind it. Water is still able to flow over the top of the weir.

To prevent London being flooded during unusually high tides and storm surges, the city constructed the Thames Barrier, a system of floodgates that stretch across the width of the river (see figure 3). The barrier is triggered if predicted water levels are above a certain height. If this happens, the gates rise to stop the incoming water. Once the water recedes, the danger has passed and the gates are lowered.

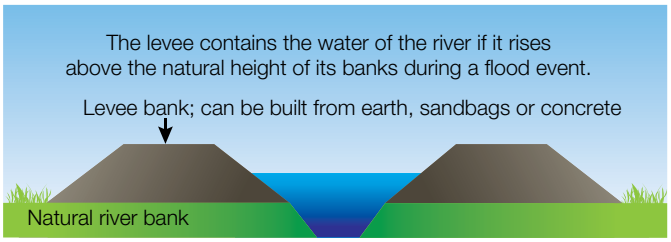
Another way to manage the risk of damage from floods is to stop building on low-lying land that is guaranteed to flood. Unfortunately, in many urban areas this land has been developed, which increases the chance of property damage in a flood.

FIGURE 1 Lake Wivenhoe, Queensland, at 190 per cent capacity, January 2011



Since 2006, the Brisbane City Council has offered a residential property buy-back scheme. This scheme gives people the opportunity to sell their property to the council if they live in a low-lying area that has a 50 per cent chance of flooding every year. People will not be allowed to build on this land again. For this initiative to be successful, it is essential that the price offered by the council is similar to what the owners would get in a private sale; otherwise there is no incentive to use it.

FIGURE 2 An artificial levee



Unfortunately not all countries have the finances to fund property buy-backs or large-scale barrier building. Bangladesh, for example, experiences annual flooding during the **monsoon** season. In response to this, homes are usually built on raised land above flood levels or on stilts.

monsoon the rainy season in the Indian subcontinent and South-East Asia

In order to prepare the population for the arrival of floods, Bangladesh has developed a flood forecasting and warning system that can be broadcast via newspapers, television, radio, the internet and email. Regrettably, due to the growing population in the capital of Dhaka, building is now occurring on low-lying land that was previously used to store floodwater (see figure 4). As a result, many people are still being affected by flooding. In 1998, 65 per cent of Bangladesh was inundated. Twenty million people needed shelter and food aid for two months.

FIGURE 3 The Thames flood barrier, seen here with its gates up



FIGURE 4 In Dhaka, homes are built on stilts to avoid the floodwaters.



eBookplus

Interactivity
Responding to floods
Use this interactivity to learn more about common flood control measures.
Searchlight ID: int-3085

Weblink
Bureau of Meteorology

ACTIVITIES

IDENTIFY
1 What flood management techniques are being used in Brisbane?
2 Where are you at most risk from flood when building?

EXPLAIN
3 Look at figure 2 and use it to help write a definition for the term *levee*.
4 How can an early warning system reduce the risk of a flood disaster?
5 Why might population growth increase the risks from floods?

INVESTIGATE
6 Use the **Bureau of Meteorology** weblink in your eBookPLUS to find out more about flood warnings. Prepare an information sheet that could be released to a rural community about to be affected by a major flood event. It should include tips on what to do before, during and after the event. Search for the area you live in and check any flood warnings it has had in the past.

APPLY
7 What do you think would happen if a dam, built to prevent floods, was already full to capacity and the area received more heavy rainfall? What might be some of the consequences?

15.8 How do tornadoes impact people and environments?

15.8.1 What is a tornado like?

eBookplus

Weblink
Tornadoes 101

Tornadoes (or twisters) are violent, wildly spinning columns of air that drop down from cloud and make contact with the ground. They are different from cyclones in that they form over land rather than over water. Unlike cyclones, they are not dependent on a supply of warm water to keep them going. Use the **Tornadoes 101** weblink in your eBookPLUS to watch a video about how tornadoes form, the damage they cause and how to survive them.

Tornadoes are ranked using a scale called the Enhanced Fujita scale (see table 1). Five categories of wind speed are estimated, based on the damage left behind. These are not wind speed measurements, because most wind speed measuring devices are destroyed during tornadoes, and because the tornadoes die out so quickly.

TABLE 1 The Enhanced Fujita scale, like the Beaufort scale, links tornado categories to the damage caused.

Scale	Wind speed		Share of all tornadoes	Potential damage
	mph	km/h		
EF0	65–85	105–137	53.5%	Minor or no damage. Some roof, gutter or siding damage; broken branches
EF1	86–110	138–178	31.6%	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors
EF2	111–135	179–218	10.7%	Considerable damage. Roofs torn off; house foundation shifted; mobile homes destroyed; cars lifted off ground
EF3	136–165	219–266	3.4%	Severe damage. Entire storeys of houses destroyed; severe damage to large buildings; trains overturned; trees debarked
EF4	166–200	267–322	0.7%	Extreme damage. Whole frame houses levelled; cars and other large objects thrown and small missiles generated
EF5	More than 200	More than 322	Less than 0.1%	Total destruction. Houses levelled off foundation and swept away; steel-reinforced concrete structures critically damaged; tall buildings collapsed

Widely used in the United States and Canada, the Enhanced Fujita scale is a new version of the original Fujita scale and was designed to expand the descriptions of damage caused at different wind

speeds. It also includes descriptions of damage to both the natural and human environments. Within the human environment, the Enhanced Fujita scale includes reference to differences in the construction quality of buildings.

15.8.2 Where is Tornado Alley?

In an average year, twisters kill 80 people and injure more than 1500. Tornadoes can occur anywhere, but most occur during spring and summer in a part of the United States known as **Tornado Alley** (see figure 2). The worst tornado on record was the Tri-State tornado in March 1925. It destroyed towns across Missouri, Illinois and Indiana, killing 689 people.

The year 2011 ranks third in the history of the United States for the greatest number of strong to violent tornadoes. This number was surpassed only in 1974 and 1965.

FIGURE 1 Anatomy of a tornado

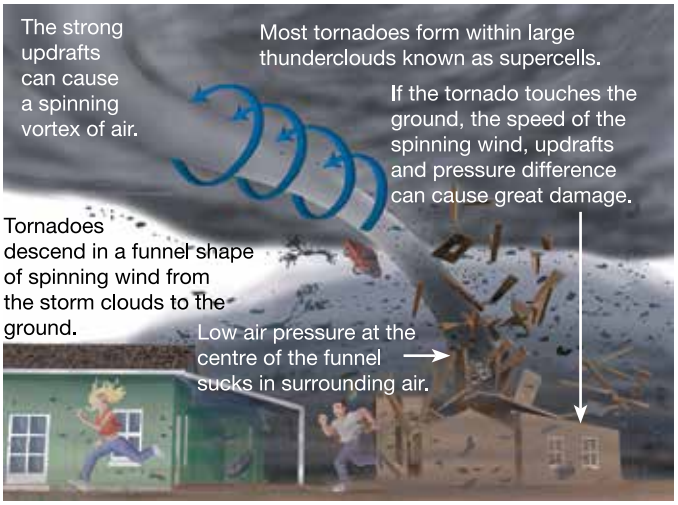
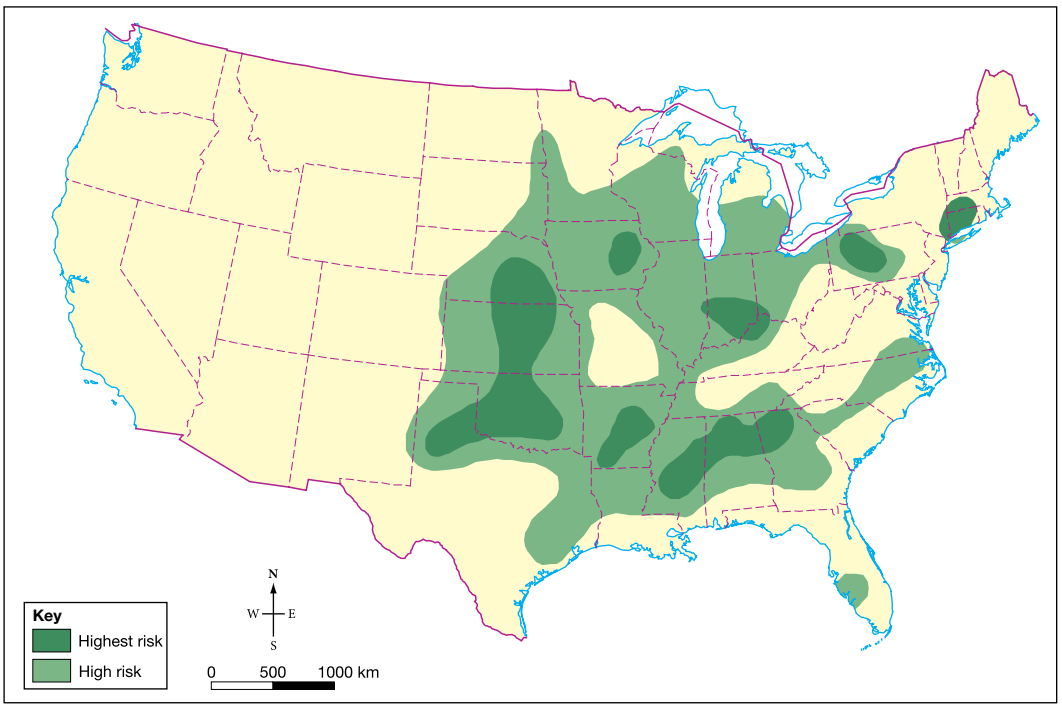


FIGURE 2 Map of Tornado Alley, showing areas of highest risk and high risk



Source: MAPgraphics Pty Ltd Brisbane

Tornado Alley
a region of the central United States, across which tornadoes are most likely to form. The core states are Texas, Oklahoma, Kansas, Nebraska, eastern South Dakota, and the Colorado Eastern Plains.

storm shelter
underground shelter where people can take refuge from a tornado

Living in Tornado Alley

The people who live in Tornado Alley are well aware of the potential disaster that they face each year during spring and summer. Building codes have been strengthened, requiring all new buildings to have strong roofs and foundations that are tethered to the structure. Most neighbourhoods have early-warning sirens that sound when a tornado is imminent. Most homes have basements or underground **storm shelters** that provide protection for people during a tornado.

Sydney experienced record-breaking wind speeds of 213 kilometres per hour during a severe storm on 16 December 2015. The Bureau of Meteorology classified the event as a tornado and the southern Sydney suburb of Kurnell was declared a disaster zone. Safety warnings were issued through social media (see figure 4) and flights were cancelled or redirected. Busy streets were blocked due to storm damage and flooding (see figure 5).

FIGURE 3 Joplin, Missouri, where 158 people were killed in May 2011, after a tornado carved a 22-kilometre path of destruction through the town



FIGURE 4 Bureau of Meteorology warnings are issued via social media.



FIGURE 5 The extent of flooding is conveyed swiftly by social media.



ACTIVITIES

IDENTIFY

1 When are tornadoes most likely to occur? Give reasons for your answer.
2 What is Tornado Alley and where is it?

EXPLAIN

3 Refer to pages 312 and 315. Explain the difference between a cyclone and a tornado.
4 Refer to figure 1. What is the ***interconnection*** between large thunderclouds and tornadoes?
5 Do you think we have tornadoes in Australia? Explain.

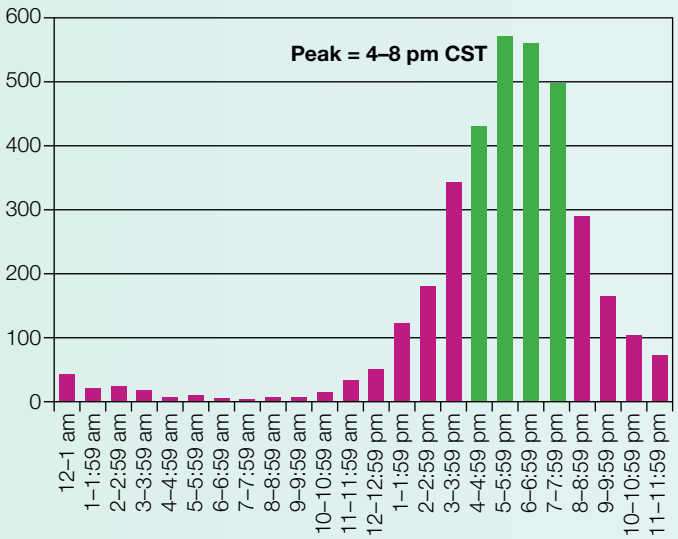
INVESTIGATE

6 Tornado Alley is well known, but it is not the only ***place*** in the world where tornadoes occur. Use the internet to find other locations where tornadoes occur regularly. Investigate one region and one tornado that has taken place. Using ICT, make a short movie clip of the event. Include information about the ***scale*** of the tornado. You must also cover the aftermath, detailing the impact on both the natural and built ***environments***.

APPLY

7 Refer to figure 2. How does the ***scale*** of risk of tornadoes occurring vary within the United States?

FIGURE 6 Hourly tornado frequency, 1950–2009



8 Study figure 6.
  a During which hours of the day are tornadoes more likely?
  b Suggest a reason for this pattern.
9 Imagine you are equipping a storm shelter. What 10 items could your shelter not do without? Justify your choices.

eBook*plus*

Interactivity
Spiralling twister
Use this interactivity to test your knowledge of tornadoes.
Searchlight ID: int-3088

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Cyclones and tornadoes

eBookplus ONLINE ONLY

15.9 What was the impact of the May 2013 tornado in the United States?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

15.10 What is a cyclone?

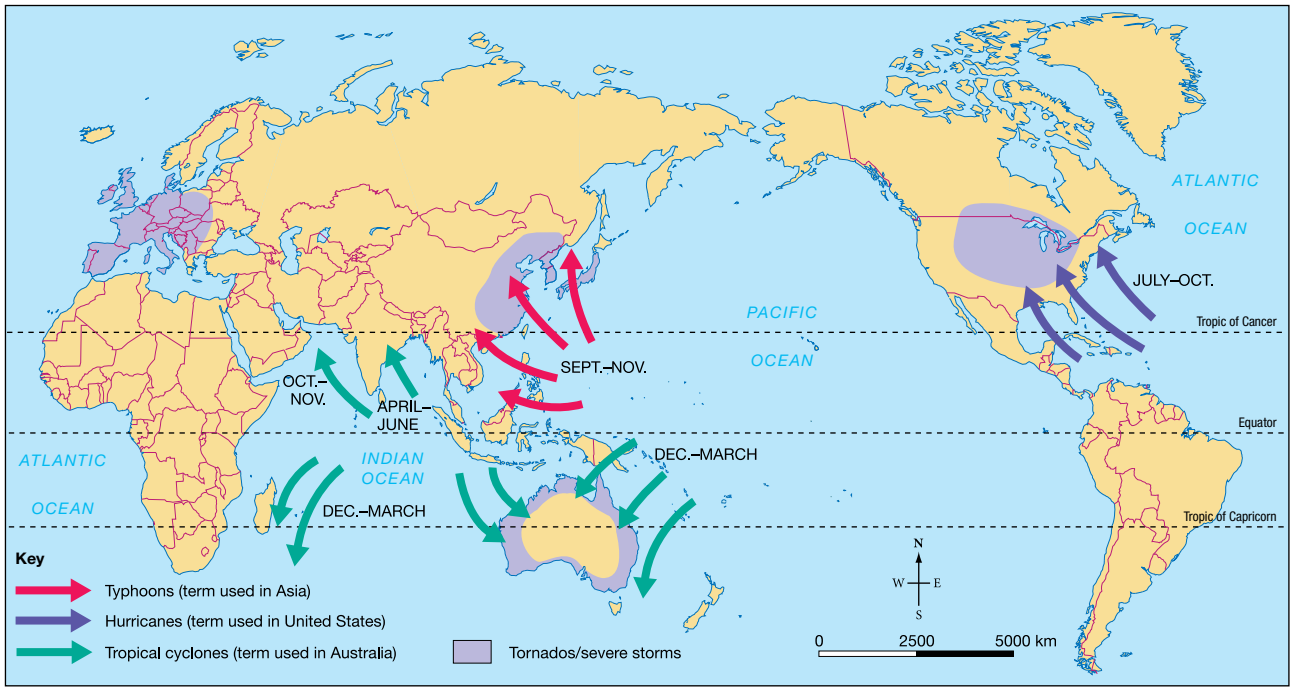
15.10.1 How are cyclones formed?

Tropical **cyclones** (called hurricanes in the Americas and typhoons in Asia) can cause great damage to property and significant loss of life. Some 80 to 100 tropical cyclones occur around the world every year in tropical coastal areas located north and south of the equator. Australia experiences, on average, about 13 cyclones per year.

cyclone intense low pressure system producing sustained wind speeds in excess of 65 km/h. It develops over tropical waters where surface water temperature is at least 27 °C.

Cyclones form when a cold air mass meets a warm, moist air mass lying over a tropical ocean with a surface temperature greater than 27 °C. Cold air currents race in to replace rapidly rising, warm, moist air currents, creating an intense low pressure system. Winds with speeds over 119 kilometres per hour can be generated.

FIGURE 1 World distribution of tropical cyclones by names used in different regions



Source: MAPgraphics Pty Ltd, Brisbane.

Cyclones are classified using the scale in table 1.

Figure 2 shows the continuous cycle of evaporation, condensation and precipitation associated with cyclones. At first the winds spin around an area about 200 to 300 kilometres wide. As the winds gather energy by sucking in more warm moist air, they get faster. In severe cyclones, winds may reach speeds of 295 kilometres per hour. The faster the winds blow, the smaller the area around which they spin; this is called the eye. It might end up being only about 30 kilometres wide. Around the edge of

the eye, winds and rain are at their fiercest. However, in the eye itself, the air is relatively still, and the sky above it may be cloudless.

gale force winds winds with speeds of over 62 kilometres per hour

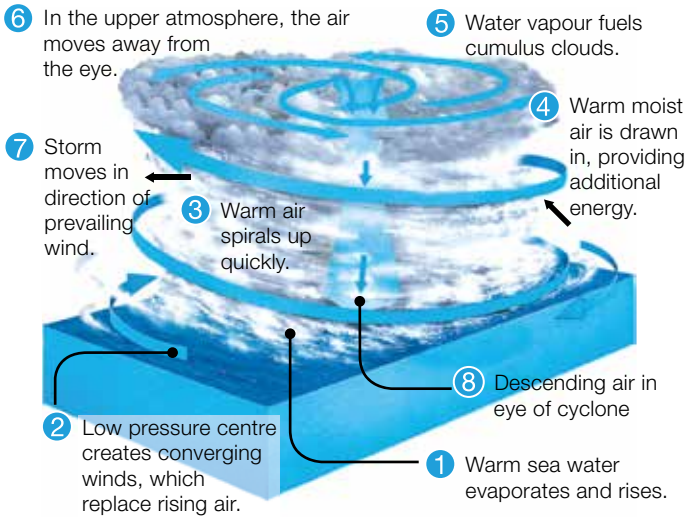
torrential rain heavy rain often associated with storms, which can result in flash flooding

storm surge a sudden increase in sea level as a result of storm activity and strong winds. Low-lying land may be flooded.

TABLE 1 Classification of cyclones using the Saffir–Simpson scale

Category	Wind gust speed	Ocean swell	Damage
1	Less than 125 km/h	1.2–1.6 m	Mild damage
2	126–169 km/h	1.7–2.5 m	Significant damage to trees
3	170–224 km/h	2.6–3.7 m	Structural damage, power failures likely
4	225–279 km/h	3.8–5.4 m	Most roofing lost
5	More than 280 km/h	More than 5.4 m	Almost total destruction

FIGURE 2 How a cyclone forms. The winds within a cyclone spin because of the rotation of the Earth. In the Southern Hemisphere, they rotate in a clockwise direction. In the Northern Hemisphere, they rotate in an anticlockwise direction.



What damage is caused by tropical cyclones?

Tropical cyclones can cause extensive damage if they cross land. **Gale force winds** can tear roofs off buildings and uproot trees. **Torrential rain** can often cause flooding, as can **storm surges**.

When a tropical cyclone approaches or crosses a coastline, the very low atmospheric pressure and impact of strong winds on the sea surface combine to produce a rise in sea level, as shown in figure 3.

FIGURE 3 Flooding caused by storm surges

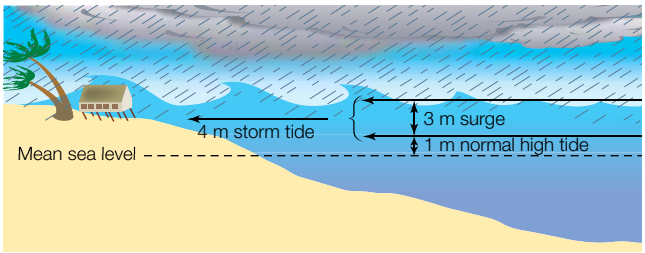


FIGURE 4 Satellite image of Typhoon Maysak, 31 March 2015

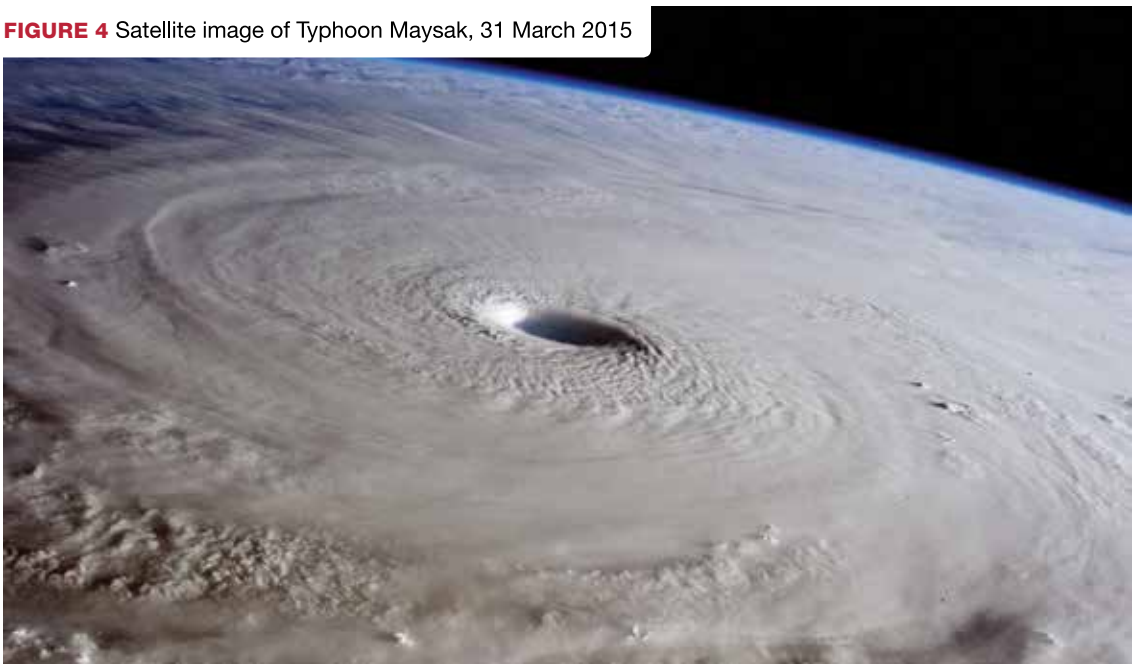


FIGURE 5 Cyclone damage to homes in Vanuatu, March 2015



ACTIVITIES

IDENTIFY

1 What conditions do tropical cyclones need in order to develop?
2 What names are given to tropical cyclones in other places?

EXPLAIN

3 Why do tropical cyclones die out if they move inland?
4 Explain the ***changes*** that a storm surge can cause to a coastal area.
5 How does the ***scale*** of a cyclone vary?
6 What is the ***interconnection*** between the warmth of seawater and cyclones?

PREDICT

7 Describe how the damage would differ between a category 1 and category 5 cyclone.
8 Why do you think many people are killed after the eye of the storm has passed over an area?
9 Cyclones are associated with destructive winds and the displacement of large volumes of water. What emergency strategies should be introduced in coastal areas to manage the risk of cyclones to humans and the ***environment?***

APPLY

10 Refer to figure 1, showing the world pattern of tropical cyclones.
   a When do most cyclones occur north of the equator? When do most cyclones occur south of the equator? Suggest a reason for this difference.
   b Name the parts of Australia most at risk from cyclone activity.
11 If the water source for cyclones is the ocean over which they form, explain why strong winds and flooding occur in ***places*** located inland from the coast.
12 Technology allows us to view cyclones on a global ***scale***. Refer to figure 4 and figure 5. What are the benefits of using these images to understand the power of cyclones?

eBook*plus*

Interactivity
Spiralling sea storm
Use this interactivity to test your knowledge of how a cyclone forms.
Searchlight ID: int-3087

myWorldAtlas
Deepen your understanding of this topic with related case studies and questions.
› **Cyclones and tornadoes**
› **Cyclone Nargis**

eBook*plus* ONLINE ONLY

15.11 What impact did Cyclone Yasi have?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

15.12 What are the impacts of typhoons in Asia?

15.12.1 What happened when Typhoon Haiyan struck?

typhoon the name given to cyclones in the Asian region

intensify to become stronger

Typhoons, hurricanes and tropical cyclones are all natural hazards that involve intense low pressure systems. They develop in different places and develop different wind patterns; however, they can all be very destructive to spaces and environments. An average of 20 major storms hit the Philippines a year. Typhoon Haiyan was the 25th tropical storm to enter Philippine waters in 2013. Some of the most impoverished areas of the Philippines were destroyed by this storm.

What happened when Haiyan struck?

Typhoon Haiyan (locally known as Yolanda) developed into a category 5 storm over the Pacific Ocean and directly affected countries such as the Philippines, Palau, Vietnam and China. Strong wind gusts of up to 314 kilometres per hour, heavy rain and waves taller than palm trees were experienced in parts of the Philippines on 8 November 2013. As figure 1 shows, the storm **intensified** over the Philippines then weakened as it moved out to the South China Sea and South-East Asia.

FIGURE 1 Typhoon Haiyan left a trail of destruction across Asia.





FIGURE 2 The storm surge from typhoon Haiyan led to widespread flooding.

Philippines

More than a million people living in low-lying areas were forced to flee as the strong winds caused massive waves. Super Typhoon Haiyan led to the deaths of more than 6500 people, 27 000 people were injured, and nearly 2000 are still listed as missing. Entire villages were flattened by winds and a storm surge damaged or swept away homes, roads, airports, farms, water and power supplies (figure 2). Typhoon Haiyan is considered to be one of the strongest storms ever to hit land.

The access to fresh water by communities affected by a typhoon is seriously affected. Water sources are contaminated by sea water and disease. Power supplies are cut and residents have to wade through waist-deep water while also dodging debris. **Shanty towns** may be transformed into floating garbage dumps.

shanty towns slum settlements housing the poor on the outskirts of major cities in developing nations. They lack basic services such as clean water, sanitation and electricity.

Farming and tourist industries were devasted by Typhoon Haiyan. Rice paddies, sugarcane plantations and coconut palms will need to be replanted and allowed to grow. The Philippines in normal times accounts for more than 40 per cent of the world's exports of coconut oil. Many tourists cancelled bookings to popular tourist resorts such as Boracoy, so jobs and valuable export income are lost (figure 3).

FIGURE 3 After the typhoon, debris littered the land as a result of devastating winds and flooding.



FIGURE 4 An aerial photograph of Tacloban city, Philippines, taken before the typhoon



FIGURE 5 Tacloban city bore the brunt of the typhoon's power.



Vietnam

Tourist communities were impacted when Typhoon Haiyan cut a path through northern Vietnam. Around 600 000 people around Ha Long Bay were ordered to evacuate from low-lying areas to community shelters, and advised to bring enough food and water supply for three days. Hundreds of flights were cancelled and boats were ordered to return to ports.

Palau

All homes on the island of Kayangel in Palau's north were destroyed during Typhoon Haiyan. Early warnings of the storm allowed residents to prepare their homes or evacuate. During the storm, radio communication was cut off but some mobile networks allowed communities to keep informed through text messages. Residents who ignored an order to evacuate were left in shelters with no access to power. It was estimated that it would take three to five months to restore water and power supplies to the island.

ACTIVITIES

IDENTIFY

1 What is a typhoon?
2 What areas were affected by Typhoon Haiyan? Describe how they were affected.
3 Does a typhoon need to cross the coastline to cause damage or loss of life? Explain.

EXPLAIN

4 Describe the ***scale*** of Typhoon Haiyan. Why did this typhoon cause devastation to a wide area spanning several countries?
5 Account for the extent of damage experienced in low-lying ***environments***.

PREDICT

6 What short-term risks and long-term risks do you think the residents of typhoon-affected communities face? Explain.

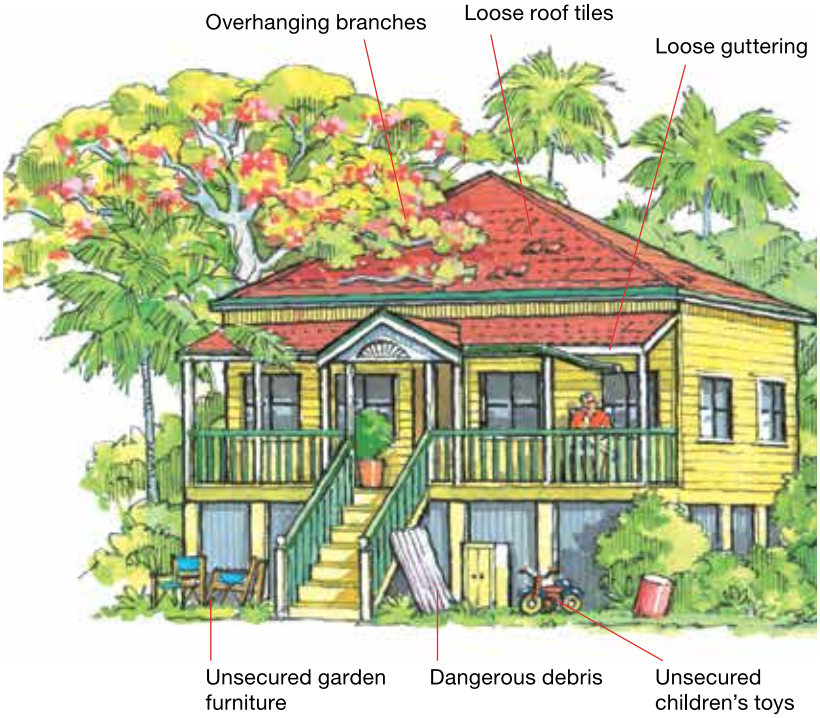
APPLY

7 What is the attraction of Boracoy and Ha Long Bay for tourists? Prepare a tourist campaign designed to promote and reassure tourists that they should choose each of these ***places*** for their next holiday.
8 Why is access to fresh water so limited after a major storm event?
9 Describe the ***interconnection*** between Typhoon Haiyan and the Philippines, Vietnam and Palau.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
- Hurricane Sandy
- Cyclone Nargis

15.13 How do we respond to extreme weather and water events?

FIGURE 1 An unprepared home



15.13.1 How do I prepare?

With today's modern technology we have access to a wealth of information that enables individuals and communities to prepare themselves for the wild winds over which they have no control. In many cases, the winds also bring vast amounts of rainfall and the land is often inundated. While we can in some ways prepare for such events, it is inevitable that both the natural and built environment will be impacted.

People who live in disaster-prone areas should know the risks associated with the potential hazards they face and the time of the year when they are at greatest risk. In Queensland, for example, where tropical cyclones bring flooding rains, houses are often built on stilts.

The key to survival is to be prepared. Securing your home and having an emergency kit are two important things that can be done on a continuing basis.

FIGURE 2 A well-prepared home

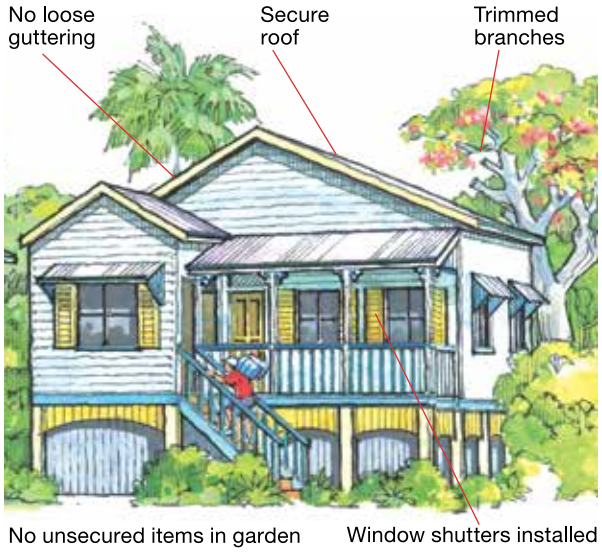


FIGURE 3 An emergency kit

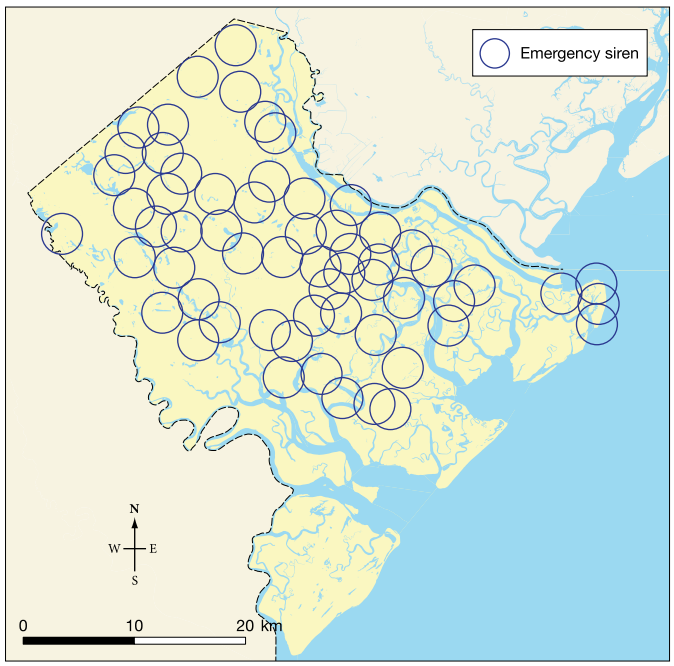


15.13.2 What happens in Chatham County?

Chatham County is located in the US state of Georgia. It has a population of approximately 270 000 and occupies an area of 1637.6 square kilometres.

On average, Chatham County expects up to 19 severe thunderstorms each year. As Georgia lies in Tornado Alley, people in Chatham can also expect an average of six tornadoes each season. In order to assist residents, a network of early-warning sirens has been installed in places where people typically tend to gather. Ninety-five per cent of the county is covered. When the sirens give out their distinctive, extended wail, residents know to seek shelter. Most homes and public buildings in the county are equipped with storm cellars.

FIGURE 4 Location of sirens in Chatham County



Source: Spatial Vision

FIGURE 5 Entrance to a storm cellar



Did you know?

- Dwellings in regions that are prone to snow and heavy rain have steeply sloping roofs to prevent the build-up of water, ice and snow on the roof. In contrast, houses in hot, dry climates often have flat roofs.
- When cyclones and tornadoes are approaching, you should turn off all power.

- A small room such as a bathroom is the safest place to take refuge if you do not have access to a storm cellar.
- Special building codes exist in areas prone to tornadoes and cyclones, with their associated strong winds.
- Shutters on windows help keep water out and reduce the likelihood of injury from broken glass.

FOCUS ON FIELDWORK

Responding to a flood hazard

Task
Devise a plan for a response to a flood at your school, in your town or suburb

Preparation
Create a map of a part of your school, town or suburb *most likely* to flood.
Consider the image shown in figure 6.

Fieldwork
In small groups, decide which of the strategies used in the image would be appropriate for your site. Propose locations for each strategy shown in figure 6. Propose two evacuation points and photograph them.

Reflection
In your opinion, what makes a good evacuation point? Which of your evacuation points is best? Justify your reasons.

FIGURE 6 Flood hazard warning sign



ACTIVITIES

EXPLAIN
1 Study figures 1 and 2. Explain to the people who live in the house shown in figure 1 what they need to do to prepare their home for the next cyclone season. Identify particular hazards and the potential risks they pose.
2 Explain why the homes shown in figures 1 and 2 are elevated.
3 What do you think poses the biggest threat — wind or water? Justify your choice.
4 What have people in Chatham County done to deal with hazards in their ***environment***?

PREDICT
5 What do you think the people who live in figure 2 are preparing for? Give reasons for your answer.

APPLY
6 The residents of the house shown in figure 2 live in a ***place*** that has been placed on cyclone alert and have asked you for advice. They have begun preparing an emergency kit like the one shown in figure 3. Other than food, what items would you suggest they include?
7 What items do you think you would need in a blizzard that you would not need in a thunderstorm, tornado or tropical cyclone? Explain.
8 Which regions within Chatham County are not well covered by sirens? Use evidence from the map to suggest a reason for this.

15.14 How do we manage extreme weather and water events?

15.14.1 How do we predict extreme events?

Climate change is any change in climate over time, whether due to natural processes or human processes. Evidence shows that extreme weather events are occurring more frequently in a range of places. Around the globe, temperatures are increasing, polar ice is melting and sea levels are rising. Studies of this change to the environment assist in the development of management strategies to help vulnerable communities.

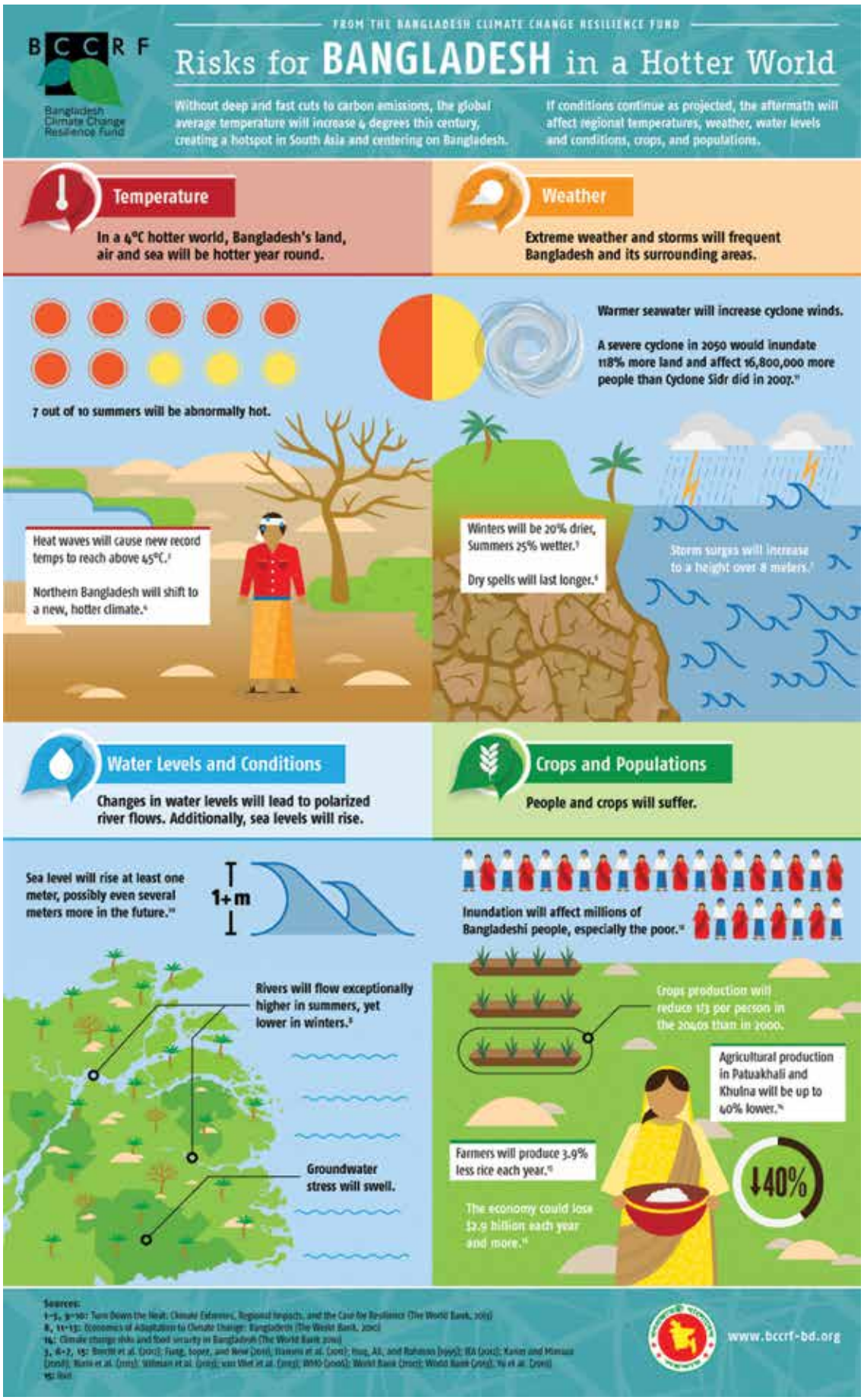
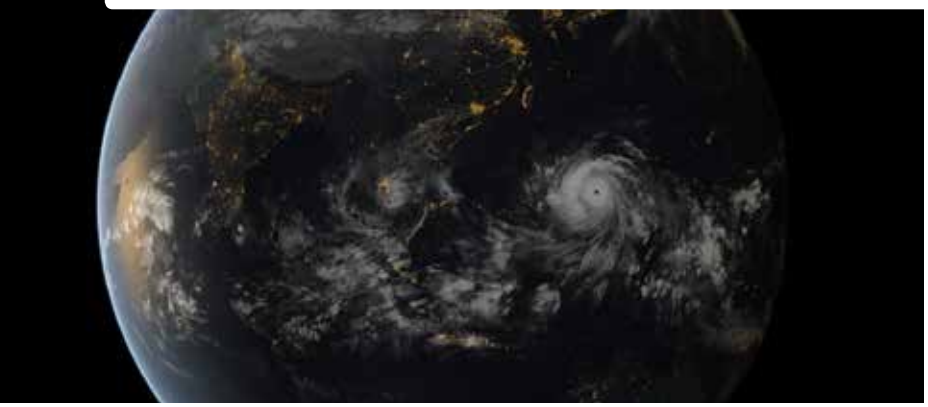


FIGURE 1 Predicted changes to our environment as a result of climate change

FIGURE 2 This global view of a tropical cyclone provides a valuable perspective on the threat of a hazard.



In response to changes to weather events, efforts are being made to ensure natural hazards are being closely monitored on a global scale. Satellite technology is being used to examine the development and movement of intense weather patterns. This data is analysed and shared, enabling us to develop a better understanding of current patterns and to develop future policy. Images of the development of a cyclone show atmospheric measurements such as wind strength, temperature, rainfall intensity and air pressure. Forecasts enable emergency services to predict when a hazard such as a cyclone will reach land and put communities at risk of harm.

FIGURE 3 Social media warning of tropical cyclone threats based on Rapidscat technology

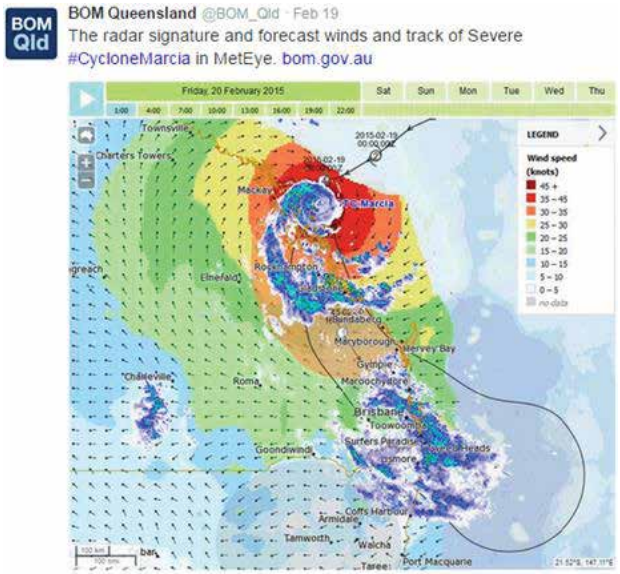
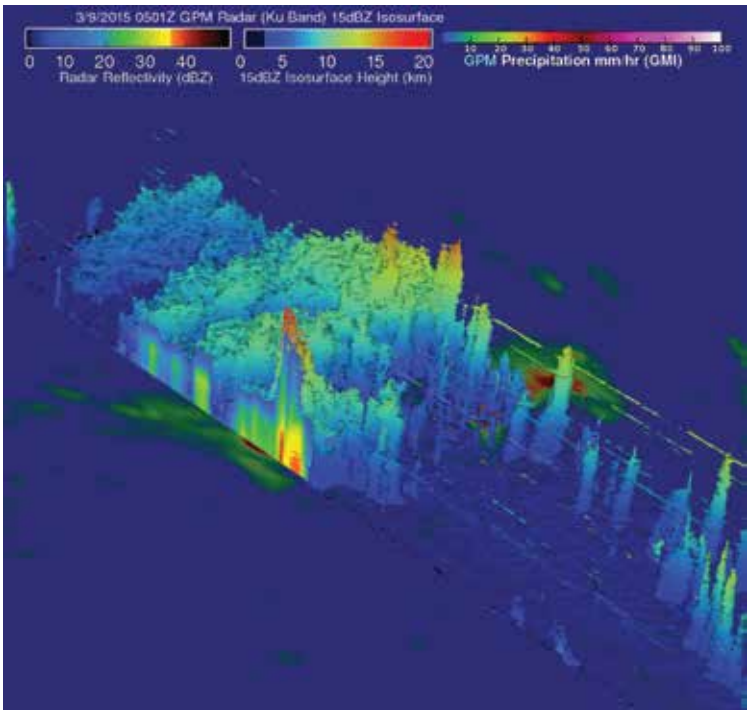


FIGURE 4 The anatomy of Cyclone Pam is visible as radar technology measures the storm.



15.14.2 Responses

When forecasts suggest that an extreme weather event will affect a particular region, responses are put into place to protect and prepare communities. Warnings are issued to fishing boats along the coast advising them to return to shore; residents of low-lying places may be evacuated to safer areas; and emergency supplies of water, shelter and medical supplies are organised.

Being interconnected

Local people are usually the first to start rescue and relief efforts. The governments of countries affected by severe natural hazards are initially overwhelmed by the community need. Water, health, power, communication and transport services may all need to be restored. Governments may pledge emergency support in the form of monetary aid, skilled personnel and emergency rations of bottled water, medical supplies, and food and temporary shelters for the displaced and homeless. Defence personnel may be deployed to ensure that unlawful activities do not occur. The National Critical Care and Trauma Response Centre based in northern Australia can respond quickly to national and international disasters. Many non-government organisations (NGOs) also provide for the emergency needs of the homeless and injured. Individuals around the world can contribute to the efforts of these organisations through donations and volunteer efforts.

FIGURE 5 Safe water supplies are difficult to access during a hazard, as flooding and burst pipes lead to water contamination and disease.



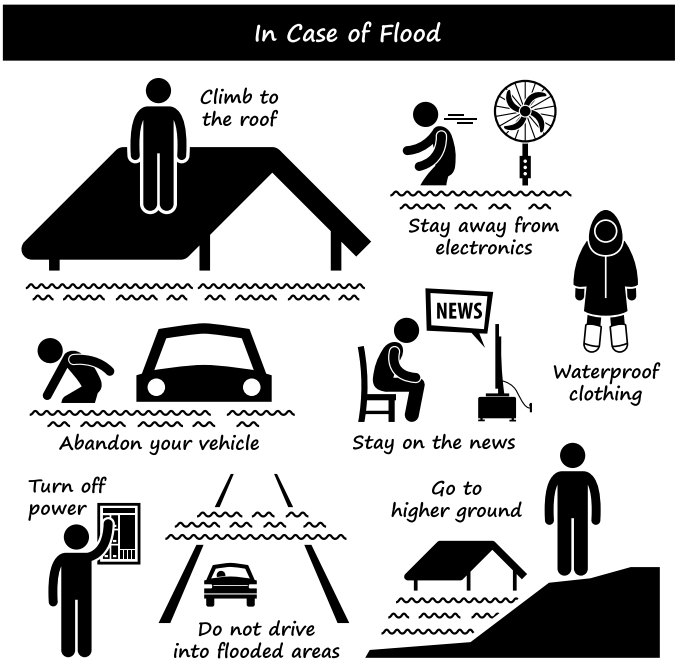
FIGURE 6 Power supplies can be cut and live power can cause danger within the community.



FIGURE 7 After the disaster, law and order need to be restored.



FIGURE 8 A simple education message designed to prepare people for flooding



How can we plan for the future?

Minimising the risks of future hazards is important. This can be done by constructing sea walls to secure coastal areas vulnerable to erosion; urban planning; educating people at risk; and developing a warning system to alert local communities.

ACTIVITIES

IDENTIFY

1 Outline the ways we can become more ***interconnected*** when an extreme weather event occurs.
2 What can *you* do as an individual to respond to communities in need?

EXPLAIN

3 Why is climate ***change*** linked to extreme weather events?
4 Explain how the use of technology enables us to be better prepared for extreme weather events using specific examples.

INVESTIGATE

5 'Climate change is being blamed for the higher incidence of extreme weather events.' Working with a partner, select one extreme weather event and suggest two reasons to support this statement and two reasons that argue against this claim.
6 In many isolated communities or communities located in poorer developing regions, there are often low levels of literacy and limited resources to respond to natural hazards. Develop a poster or a short video presentation designed to communicate a survival message to people in these areas.

15.15 How does flooding affect the Narrabeen lagoon?

15.15.1 Narrabeen lagoon

Narrabeen lagoon is 55 square kilometres in size and is the largest coastal lagoon in the Sydney region. The suburbs around the lagoon support a large number of residents. Residents and tourists are attracted to the area to enjoy a range of outdoor recreational opportunities such as fishing, kayaking, cycling, sailing, walking and picnics.

The main body of Narrabeen lagoon is fed by stream flow that drains off surrounding elevated suburbs. The lagoon is connected to the sea by a narrow channel that is often blocked by sand movement along North Narrabeen beach. Severe storms can result in flooding of the low-lying suburbs and roads. Rainfall totals and river levels are monitored throughout the catchment, and warnings are issued to motorists and residents when flooding is predicted.

FIGURE 1 Road closures disrupt traffic during flooding.



ACTIVITIES

IDENTIFY

1 What is the direction of stream flow along Deep Creek?
2 What is the area reference of:
   a Cromer Heights
   b Sanctuary Island
   c the lagoon mouth (where the lagoon flows out to the sea)?
3 Identify the human feature found at:
   a GR 989375
   b GR 945400
   c GR 958408.

EXPLAIN

4 Which areas in figure 2 are less likely to flood in the Narrabeen lagoon region? Why?
5 The Wakehurst Parkway is an important link between places in Sydney's north.
   a Where do you think the flood gates that block the road during flooding are located?
   b Use evidence from the map to explain why you think this would be a good location for the gates.

APPLY

6 Use a digital drawing tool to download the map image and to highlight the areas that you think are likely to flood.
7 Which areas would require residents to evacuate during flooding? Explain why.

INVESTIGATE

8 Research the methods used to warn local residents of flooding. Select one method to evaluate. What is good about this method of communication? What are some of the problems associated with using this method of communication?

FIGURE 2 Topographic map extract of Narrabeen Lakes



Key

Built-up area	Building area	Building point	Distributor road
Lake, ocean	Cultural area	Water point or tank	Local road
Cliff; wharf or pier	Restricted area	Landmark	Track
Sand	Watercourse or canal	Monument	Path
Rocks awash	Contour with height (metres)	Helipad	Bridge
Inland rocks	Spot height (metres)	Arterial road	

N W E S

0 1 2 km

Contour interval 20 metres

Source: Land and Property Information, NSW.

eBook*plus* ONLINE ONLY

15.16 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

15.3 SkillBuilder: Cardinal points: wind rose

15.3.1 Tell me

What are wind roses?

A wind rose is a diagram that shows the main direction of wind. It shows wind direction, speed and frequency. Wind directions can be divided into eight or 16 compass directions.

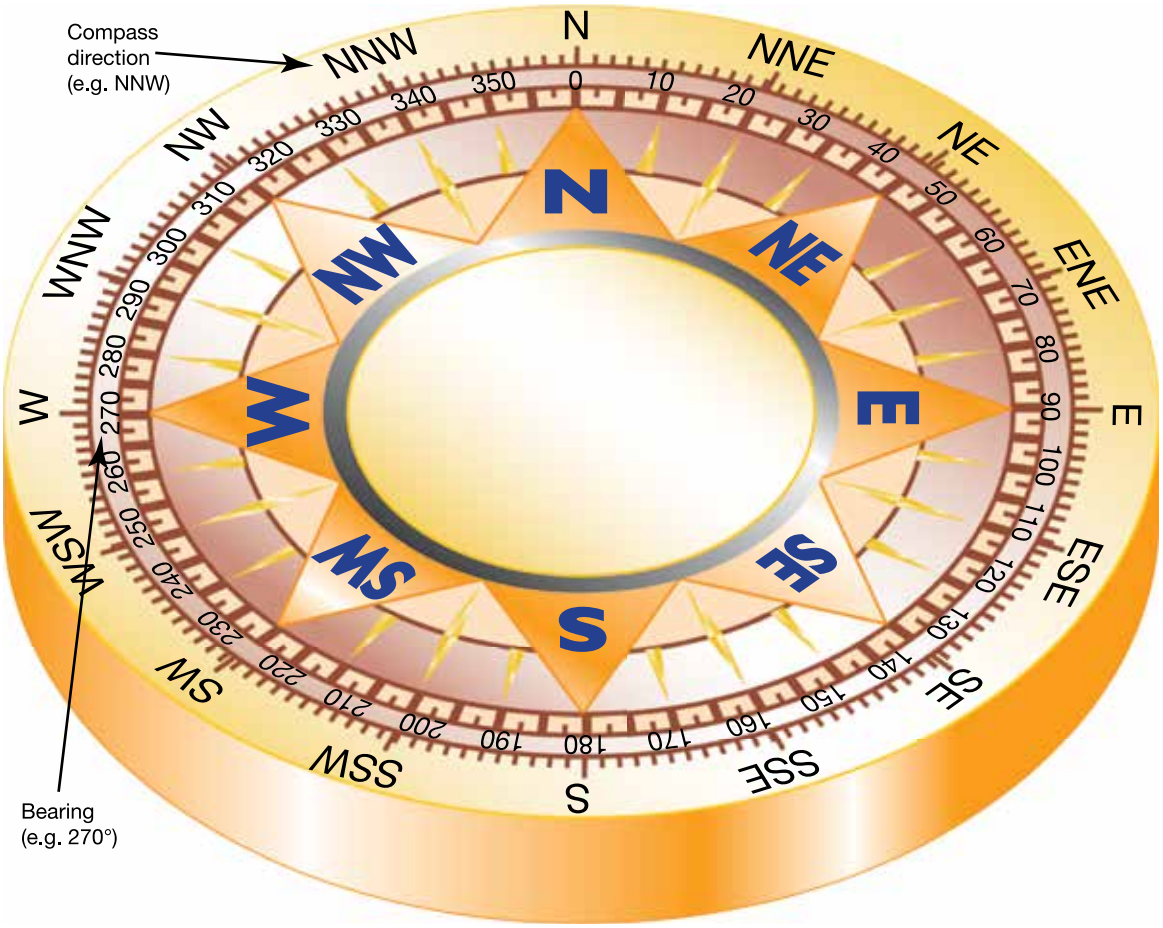
Before you can understand a wind rose, you must know your cardinal points. Let's quickly revisit these first.

Cardinal points

A compass has four main (or cardinal) points: north, east, south and west (figure 1). These four cardinal points are used to describe direction. For example, if you are facing north, then south is behind you, east is to your right and west is to your left.

To give more accurate directions, the four cardinal points can be divided again into inter-cardinal points: north-east, south-east, south-west and north-west. For even finer definition, points that divide each inter-cardinal point are shown in figure 1. Cardinal and inter-cardinal points are used in wind roses.

FIGURE 1 A compass



Why are wind roses useful?

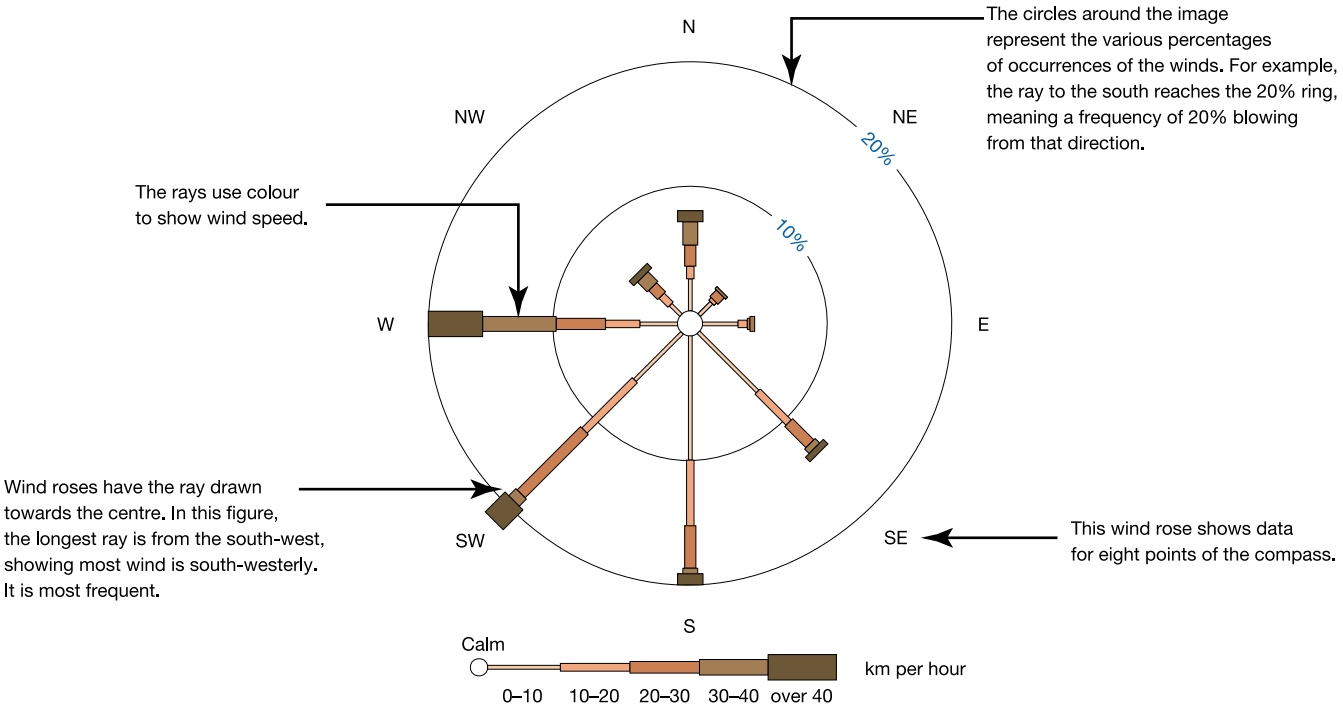
Wind roses are useful to display wind direction, speed and frequency so that patterns can be quickly seen. We name wind direction according to the direction *from* which the wind is blowing. For example, when a sailor reports a strong southerly, this means that the wind is coming *from* the south.

Model

To interpret a wind rose, remember:

- Wind roses have the rays drawn towards the centre. In figure 2 the longest ray is from the south-west, which shows most of the wind is south-westerly. It is most *frequent*.
- The circles around the image represent the various percentages of occurrences of the winds. For example, if the ray to the south just reaches the 20 per cent ring, it means a frequency of 20 per cent blowing from that direction.
- The rays use symbols and colour to show wind *speed*.
- This wind rose shows data for eight points of the compass.

FIGURE 2 A wind rose



eBook*plus*

eLesson
Cardinal points: wind rose
Searchlight ID: eles-1638

15.3.2 Show me

How to read a wind rose

You will need:

- a wind rose (figure 3)
- a ruler.

Procedure:

To describe wind patterns using a wind rose you need to examine the direction, length and width of the rays.

STEP 1

Determine the direction of wind with the highest frequency by finding the longest ray. In this case, the predominant wind direction that Melbourne experienced was a southerly.

STEP 2

Determine the direction of wind with the highest speed by finding the widest ray. In this case, the highest speeds were reached by northerly winds.

eBook*plus*

Interactivity
Cardinal points: wind rose
Searchlight ID: int-3134

STEP 3

Work out the general pattern and main features of wind direction and strength. In this case, the wind rose shows us that the predominant winds were southerlies, which blew over 30 per cent of the time. This was closely followed by northerlies, which blew less than 30 per cent of the time. Winds blew from the west only around 10 per cent of the time, and easterlies were very infrequent.

15.3.3 Let me do it

Developing my skills

Using figures 3 and 4, answer the questions that follow.

FIGURE 3 Wind speed and direction rose for Melbourne, annual average at 3 pm

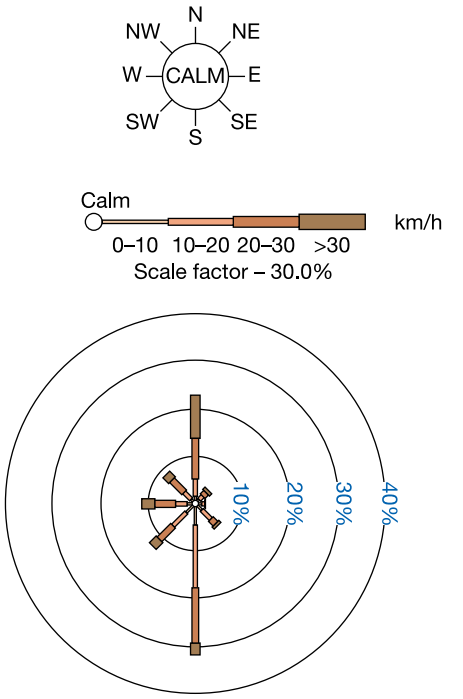
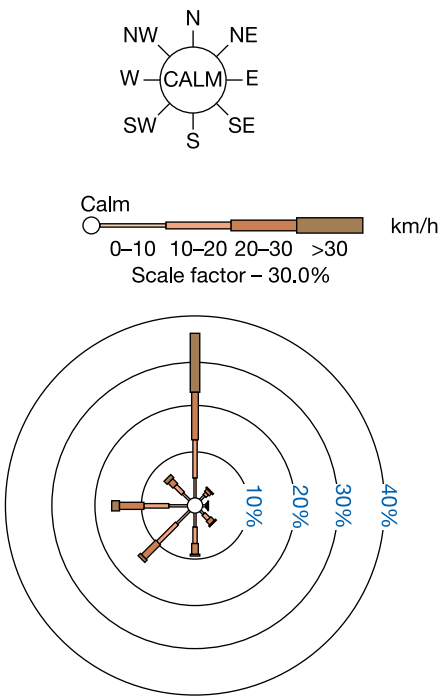


FIGURE 4 Wind speed and direction rose for Melbourne, annual average at 9 am



Questions

1. In which direction are the highest frequency winds for Melbourne, 9 am?
2. In which direction are the highest speed winds for Melbourne, 9 am?
3. In which direction are the lowest frequency winds for Melbourne, 9 am?
4. In which direction are the lowest frequency winds for Melbourne, 3 pm?
5. Is there any direction that has no wind for Melbourne, 3 pm?
6. What is the percentage frequency of northerly winds for Melbourne, 3 pm?
7. Compare the change in wind direction patterns at 9 am and at 3 pm.

Checklist

I have:

- found the longest ray to determine the direction of wind with the highest frequency
- found the widest ray to determine the direction of wind with the highest speed
- worked out the general pattern and main features of wind direction and strength.

Skills questions

1. The main purpose of a wind rose is to help us understand:
   a. slope
   b. wind patterns
   c. wind temperature
   d. rainfall.
2. Wind roses are used to show:
   a. wind direction
   b. wind speed
   c. wind frequency
   d. all of the above.
3. Draw a diagram to show the cardinal and inter-cardinal points.
4. Why is it important to remember to name wind direction according to the direction from which the wind is blowing?

15.6 SkillBuilder: Creating a simple column or bar graph

15.6.1 Tell me

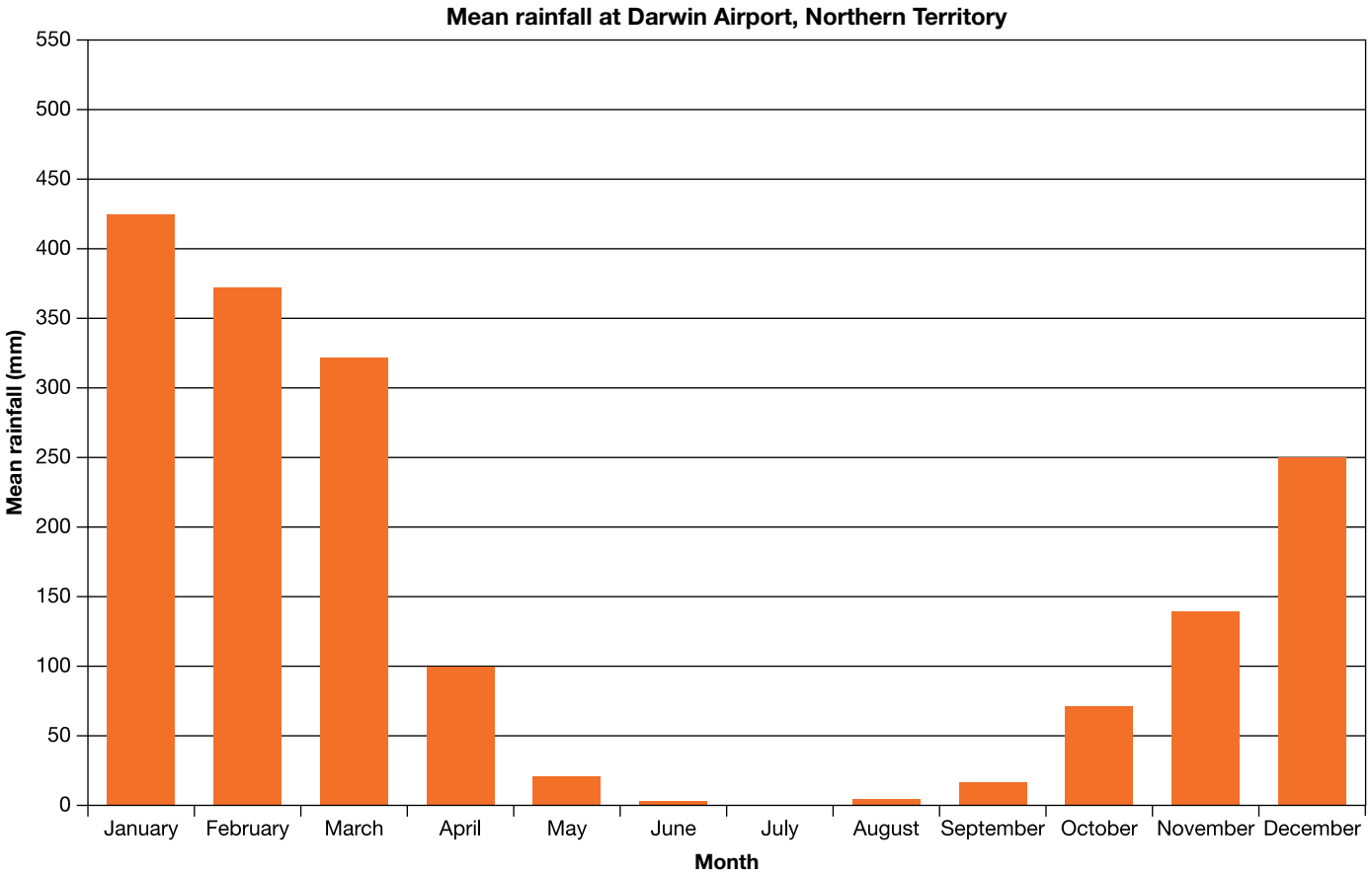
What are column or bar graphs?

Column graphs show information or data in columns. In a bar graph the bars are drawn horizontally and in column graphs they are drawn vertically. They can be hand drawn or constructed using computer spreadsheets.

Why are column graphs useful?

Column graphs are useful for comparing quantities. They are useful to understand and visualise data, see patterns and gain information. For example, we can use them to help understand rainfall patterns in different months (figure 1).

FIGURE 1 Rainfall at Darwin Airport



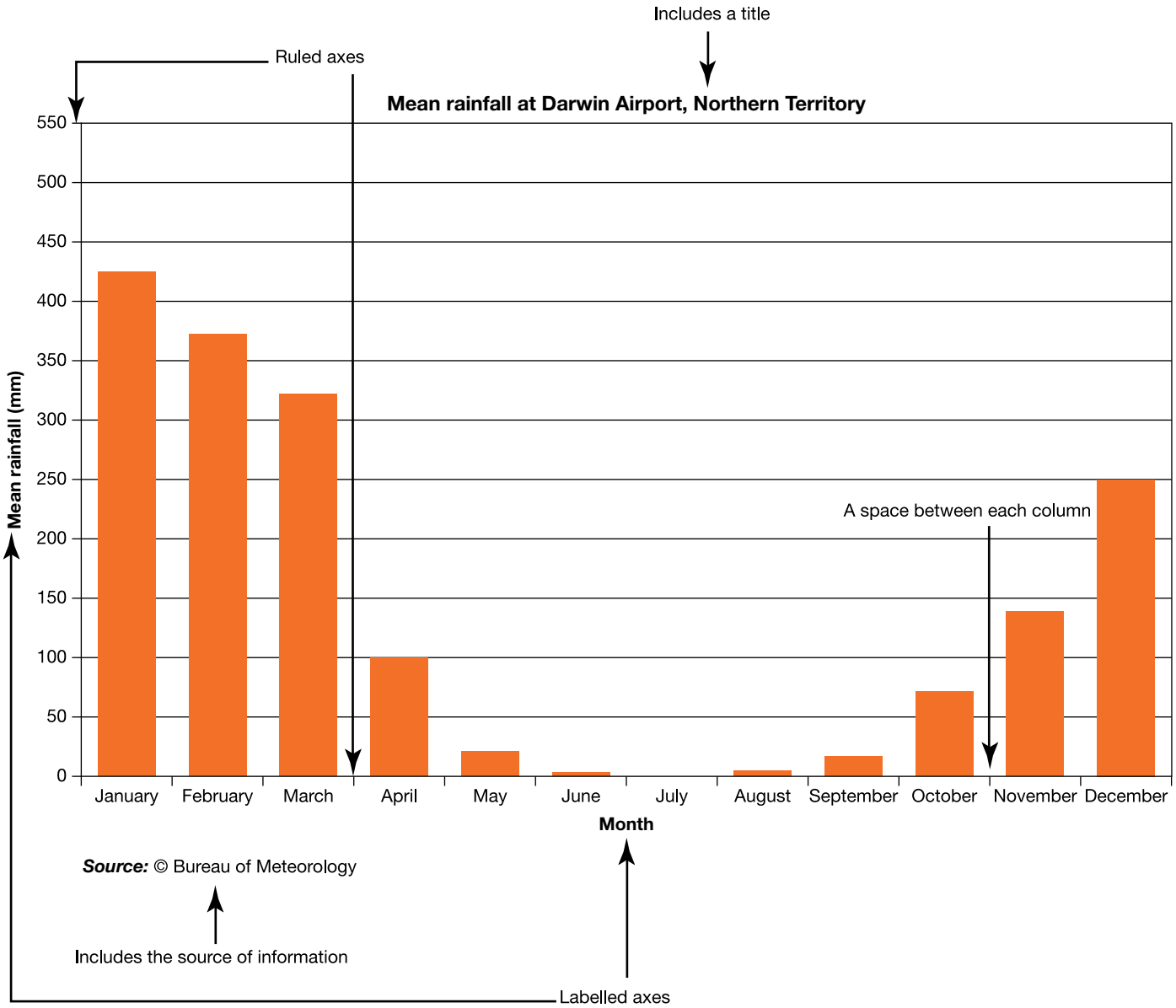
Source: © Bureau of Meteorology

Model

A good column graph has:

- been drawn in pencil
- ruled axes
- labelled axes
- a space between each column
- a title
- the source of information.

FIGURE 2 A labelled column graph



eBook*plus*

eLesson
Creating a simple column or bar graph
Searchlight ID: eles-1639

15.6.2 Show me

How to complete a column graph

You will need:

- a table of data (table 1)
- graph paper
- a pencil
- a ruler.

TABLE 1 Mean rainfall for the years 1871 to 2016, Cardwell, Queensland

Statistics	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Mean rainfall (mm) for years 1871 to 2016	440	466	400	209	94	47	31	29	39	55	118	196	2124

Source: © Bureau of Meteorology

Procedure:

STEP 1

Examine the data. Draw a horizontal and vertical axis. Decide on the scale for each axis. For this example the vertical axis starts at zero and increases at intervals to suit the data. As the highest rainfall for any month for Cardwell is 466 mm, intervals of 50 would work. For this exercise you could use 1 centimetre to represent 25 mm.

STEP 2

Decide on the width and spacing of the columns. Each column should be the same.

STEP 3

Mark the meeting point of the two pieces of information and mark with a dot. Now complete the column. Shade it in using colour.

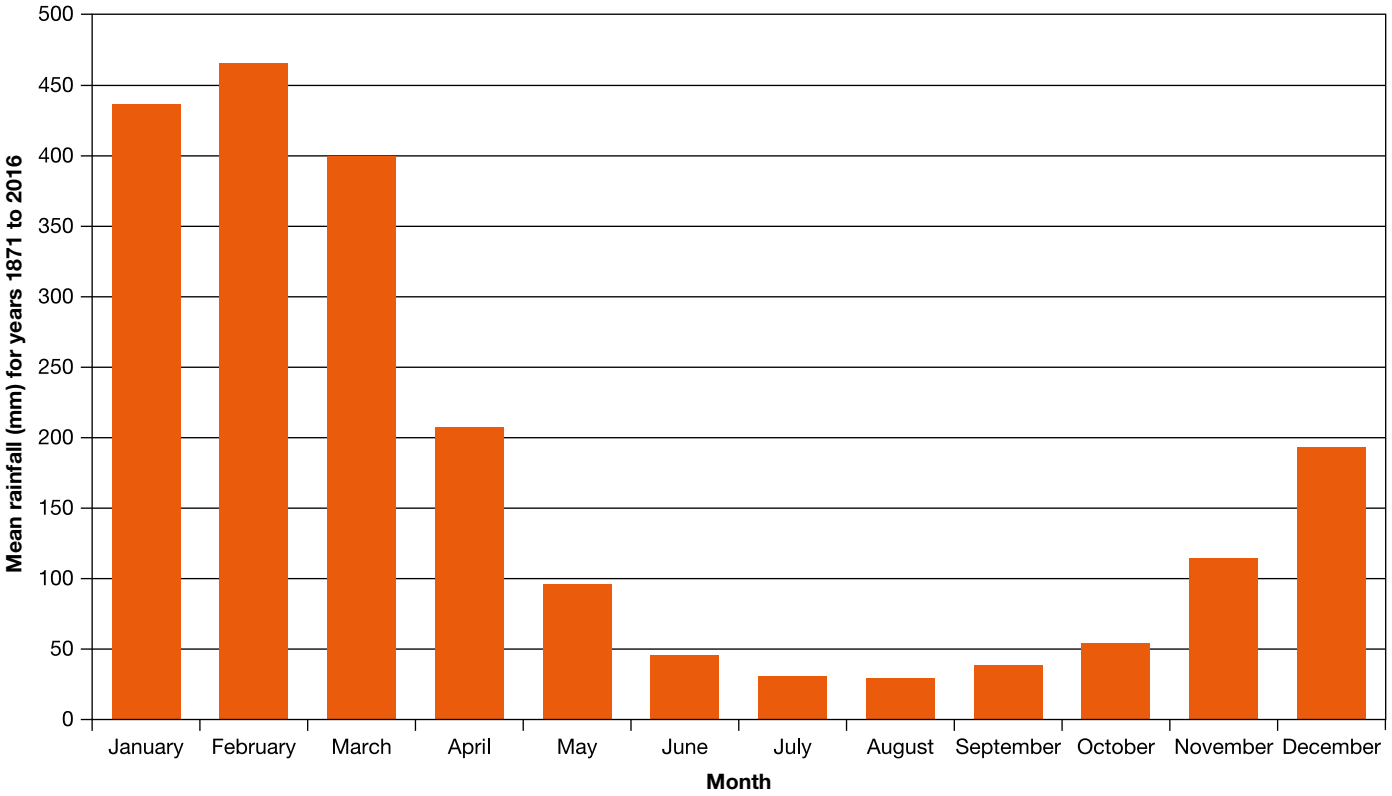
STEP 4

Name the vertical and horizontal axes and give the graph a title. Include a key if necessary.

STEP 5

Provide the source underneath as this enables the reader to check how up-to-date the statistics are.

FIGURE 3 Mean rainfall for the years 1871 to 2016, Cardwell, Queensland



Source: © Bureau of Meteorology

eBook*plus*

Interactivity
Creating a simple column graph
Searchlight ID: int-3135

15.6.3 Let me do it

Developing my skills

Using the following data, construct your own graph of rainfall in Innisfail, Queensland.

TABLE 2 Mean rainfall (mm) for the years 1881 to 2016, Innisfail, Queensland

Statistics	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Mean rainfall (mm) for years 1881 to 2016	512	597	667	460	300	187	136	117	87	88	161	266	3578

Source: © Bureau of Meteorology

Questions

1. What is the average annual rainfall for Innisfail?
2. Which month has the most rainfall?
3. Which month is the driest?
4. You plan to film on location at Innisfail for three months. As rain will be a problem, which months would be best for your requirements?
5. How does this rainfall pattern compare with your local area?

Checklist

I have:

- drawn in pencil
- ruled axes
- labelled axes
- included a space between each column
- included a title
- included the source of information.

Skills questions

1. Column graphs are used to:
   a. show the height of the land at a place
   b. compare quantities
   c. show the contours of an area
   d. all of the above.
2. A column graph would be best to show information about:
   a. the number of endangered species for different areas
   b. how population has changed in the past 100 years
   c. the shape of the land
   d. wind direction.
3. Why should you use small dots rather than big, thick pencil marks for each height on the graph?
4. Why is it important to carefully choose the vertical scale?

15.9 What was the impact of the May 2013 tornado in the United States?

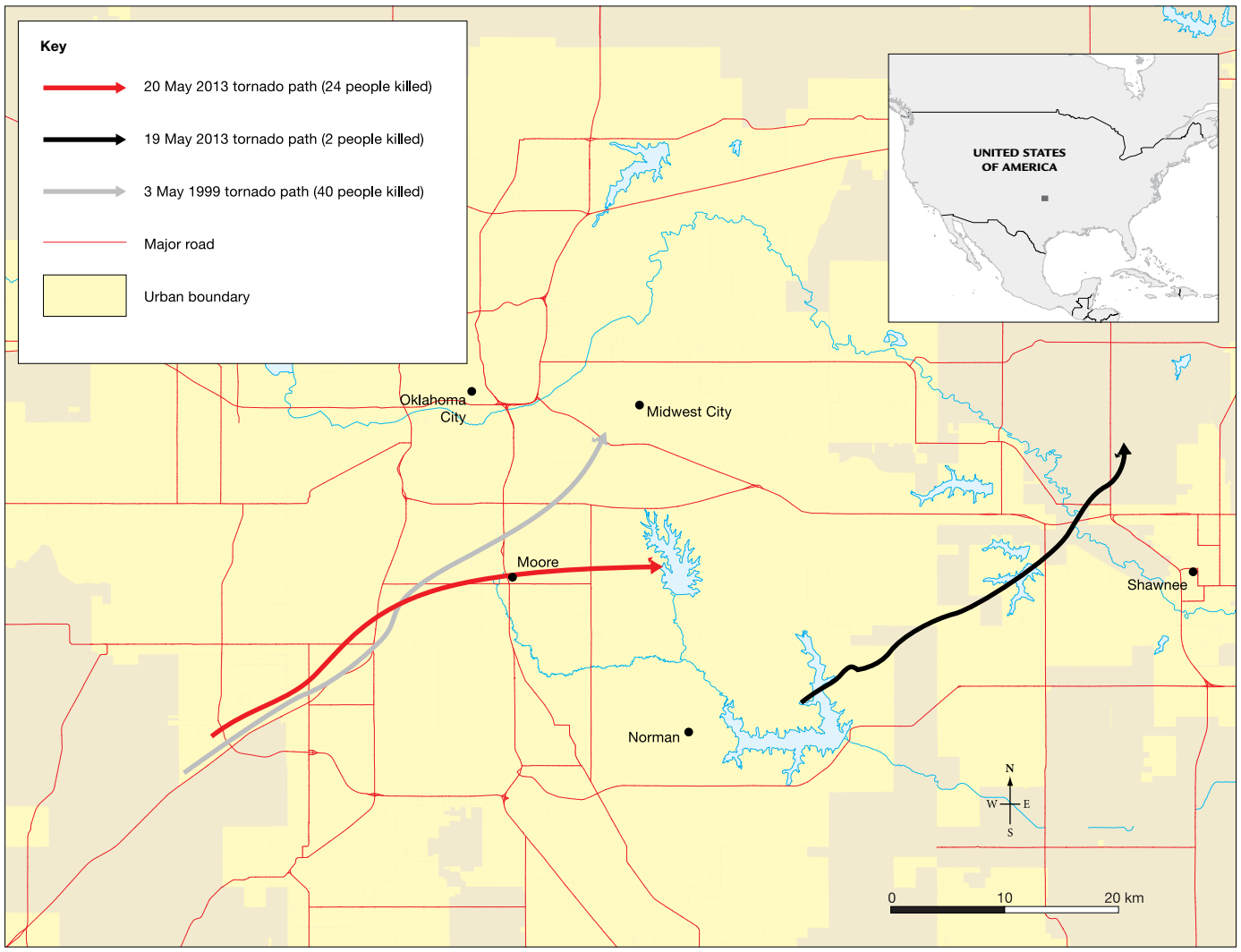
15.9.1 Oklahoma

Tornadoes can have a devastating effect on people and the environment. One such tornado descended on Oklahoma City in the United States on 20 May 2013.

A destructive supercell thunderstorm developed in central Oklahoma on 20 May 2013. Supercell thunderstorms are very large storms that can last for many hours and are responsible for nearly all of the significant tornadoes that occur in the United States. They also produce most of the hailstones that are larger than golf-ball size.

The 20 May 2013 tornado took place during a period of extreme weather across the middle of the United States and included severe-weather alerts from Texas to Michigan. A powerful weather system from the west collided with warm, moist air from the Gulf of Mexico, creating perfect conditions for tornadoes and supercell thunderstorms.

FIGURE 1 The location of the 20 May 2013 tornado in Oklahoma



Source: Spatial Vision

The red line on figure 1 shows the 2013 tornado's track, which was up to 1.6 kilometres wide on the ground. It touched down at 2.56 pm and moved north-east towards Moore (a suburb in the south of Oklahoma City), causing deaths, injuries and widespread destruction to property. The tornado lasted 40 minutes. This means that it was moving slowly for such a violent storm (winds reached up to 305 km/h), resulting in high levels of damage. It travelled approximately 27 to 32 kilometres. People were given 16 minutes' warning before the tornado touched down.

The tornado had a damage rating of EF4 (see table 1, section 15.8.1). The wide path meant the near-total destruction of buildings, including a primary school and a medical centre. Many buildings were destroyed down to their foundations. Debris from the tornado fell as far as 160 kilometres away, reaching the city of Tulsa, north-east of Moore.

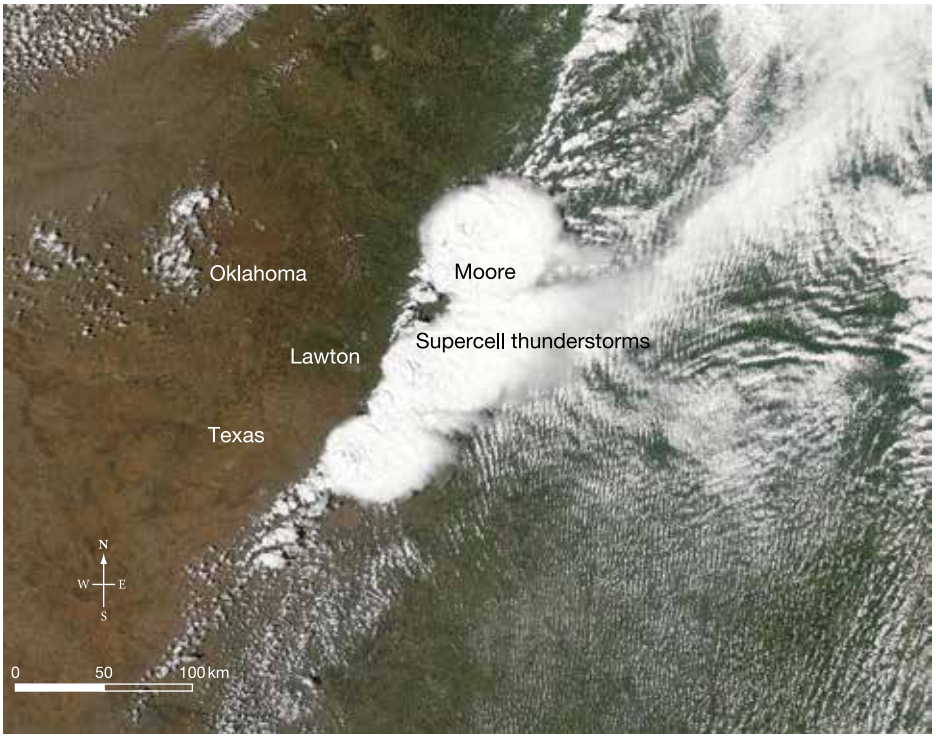


FIGURE 2 This satellite image shows the scale of the supercell thunderstorm in high-risk Tornado Alley in the United States.

FIGURE 3 Houses were flattened and cars severely damaged by the violent tornado winds in May 2013.





ACTIVITIES

IDENTIFY

1 What is a supercell thunderstorm?
2 Which conditions result in this thunderstorm?

EXPLAIN

3 Why would slow-moving tornadoes result in more destruction and damage than fast-moving ones?

INVESTIGATE

4 Describe the location of the ***places*** affected by this tornado.
5 Refer to figure 1 and use the ***scale*** to measure the extent of each tornado. What distance did each travel?
6 Use the scale in figure 2 to measure the ***scale*** and extent of the supercell thunderstorm shown in the satellite image.
7 Study figure 3 and describe the damage resulting from the tornado.

APPLY

8 Obtain a map of the area local to your school or home (e.g. from Google Earth). To understand the ***scale*** of the 20 May 2013 storm, make your school or home the centre of the map area and measure 1.6 kilometres across — this would be the area that the tornado touched on the ground. Now measure the distance the tornado travelled. Describe the area that would have been affected and the damage caused if such a tornado occurred in your local area.
9 How might you react if you had 16 minutes' warning of such an event? How could you become prepared (see subtopic 5.13)?

15.11 What impact did Cyclone Yasi have?

15.11.1 How big was Yasi?

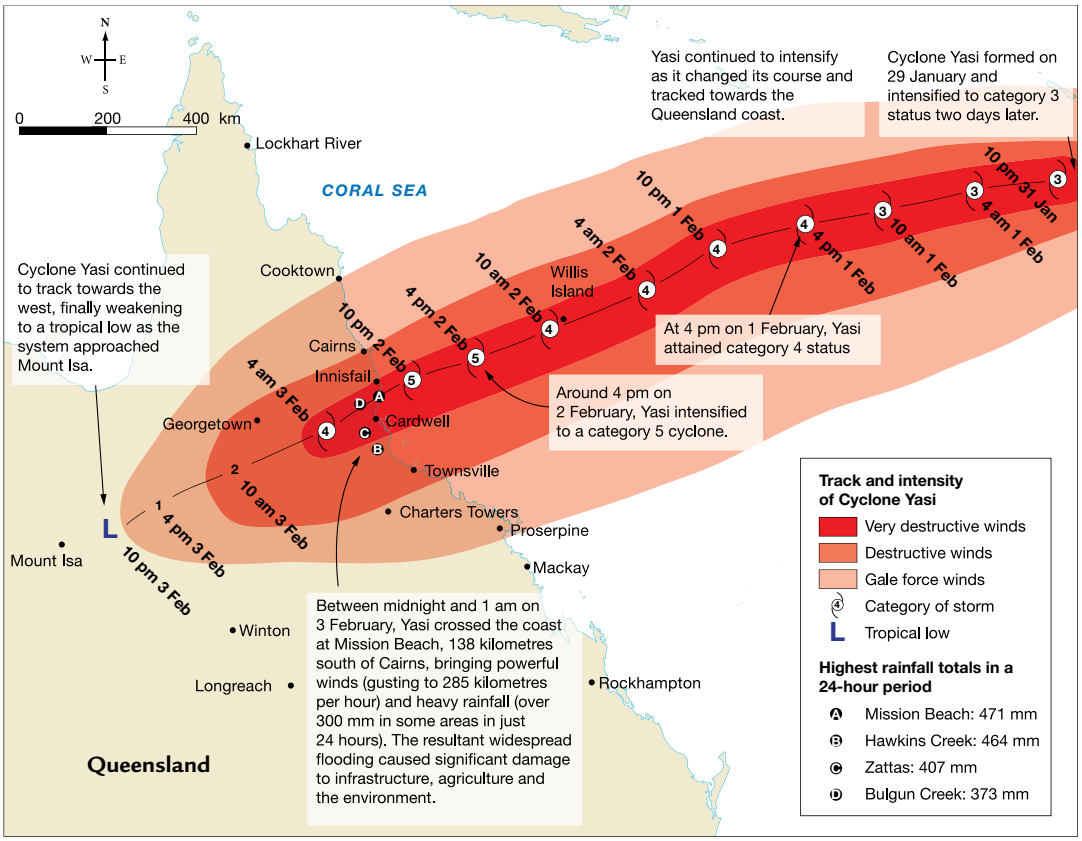
On 29 January 2011, a tropical low developed to the north-west of Fiji and began moving west. By the time it had reached Vanuatu, it had intensified to a category 1 cyclone. Named Yasi by the Fijian Meteorological Service at 10 pm on 30 January, Yasi continued to move west and **intensify**. By 10 am the following morning, Yasi had been upgraded to a category 2 cyclone, and by mid afternoon it had intensified to a category 3.

intensify to become stronger

At its peak, Cyclone Yasi was 400 kilometres wide and its eye was 30 kilometres in diameter. This massive storm travelled 500 kilometres before crossing the coastline of Australia, and then went a further 900 kilometres inland. However, it not only affected places on its **track**, or path; during its journey, Cyclone Yasi's winds affected areas up to 2000 kilometres from its path. More than 400 000 people were affected as Yasi tracked across northern Australia, and around 35 000 people were evacuated from their homes.

track the path of a cyclone

FIGURE 1 The track and intensity of Cyclone Yasi



Source: Spatial Vision

TABLE 1 Highest rainfall totals in 24 hours during the height of Cyclone Yasi

	Location	Rainfall
A	Mission Beach	471 mm
B	Hawkins Creek	464 mm
C	Zattas	407 mm
D	Bulgun Creek	373 mm

eBook*plus*

Weblinks
- Yasi animated loop — satellite
- Yasi animated loop — radar

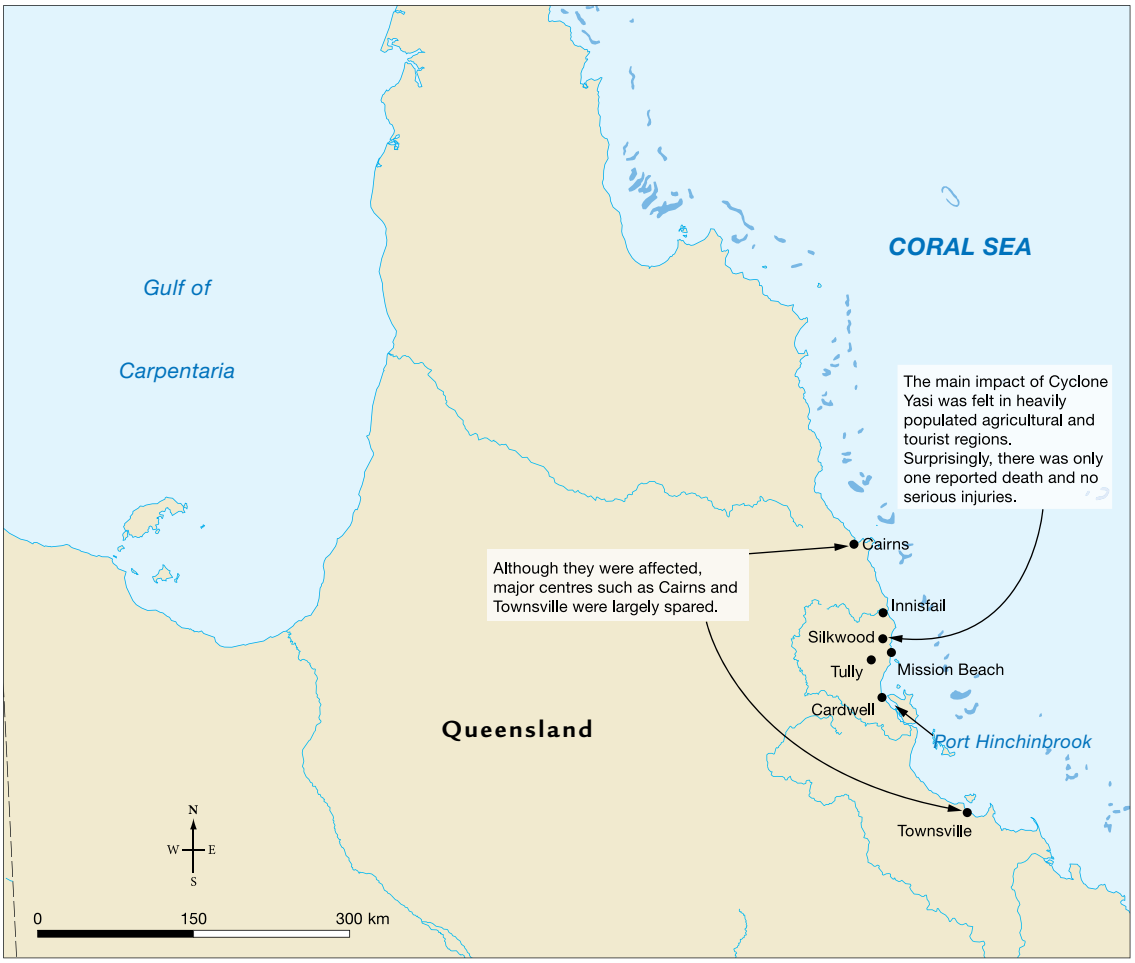
A 5-metre storm surge between Cairns and the northern beaches caused parts of the city of Cairns to be inundated. The extent of this flooding would have been greater if the storm surge had occurred on an incoming, or high, tide; fortunately, it occurred on a falling tide instead. See figure 3 in subtopic 15.10 'What is a cyclone?'.

Use the **Yasi animated loop** weblinks in the Resources tab to view the animations of Cyclone Yasi as it approaches Australia and crosses the coastline.

15.11.2 How much damage was caused?

The damage bill from Cyclone Yasi came to around AU $800 million.

FIGURE 2 The impact of Cyclone Yasi



Source: Spatial Vision







FIGURE 3 Cyclone Yasi caused considerable damage to the built environment.

A In some towns, such as Cardwell, 90 per cent of homes were damaged. Yasi tore roofs from some houses, and flattened others or split them in two.
B In some areas, such as Port Hinchinbrook marina, boats were piled on top of each other in the harbour. The force of the storm carried boats two blocks inland from the coast.
C About 200 000 properties were left without power, as 2000 power poles and over 600 kilometres of cabling were destroyed. It took more than a month to restore power to some properties.
D Roads were cut by floodwaters caused by torrential rain and storm surge.

Agriculture

Yasi caused approximately $300 million damage to the agricultural industry, which had also been heavily hit by Cyclone Larry in 2006. The region supplies 90 per cent of Australia's bananas and one-third of its sugar. With 95 per cent of the area's banana crop wiped out, prices soared to over $14 a kilogram in 2011.

FIGURE 4 About 90 per cent of Australia's banana crop was destroyed in 2011 by Cyclone Yasi.



Environment

It is estimated that some parts of the Great Barrier Reef will take 10 to 20 years to recover from the impact of Cyclone Yasi, with some coral gardens reduced to little more than rubble. However, there are also substantial areas of the reef that escaped unscathed.

The tropical rainforest habitats of endangered species such as the southern cassowary and mahogany glider have also taken a battering. Fortunately, the evolution of both the marine and rainforest ecosystems has enabled these habitats to recover from cyclone damage. In both environments, there is evidence of both damage and recovery.

Human intervention has also played a major role in the recovery of the cassowary population. In the year after Cyclone Yasi, local volunteers cut up approximately 165 tonnes of fruit for the birds, which was then either dropped by helicopter or taken to established feed stations. In addition, locals cared for injured adult birds and orphaned or abandoned chicks.

FIGURE 5 Habitat destruction caused by Cyclone Yasi on the Cassowary Coast means limited food for wildlife.



eBook*plus*

Weblinks
Yasi animated loop

dissipation the break-up or disintegration of something

ACTIVITIES

IDENTIFY

1 Create a timeline showing the development of Cyclone Yasi, from formation to **dissipation**.
2 Which phase of the cyclone would have been the most dangerous? Give reasons for your answer.

EXPLAIN

3 Explain how the extent of flooding could have been greater if it had occurred at a different time of the day.
4 Explain what conditions would have been like during the cyclone.
5 Given the destructive force of Cyclone Yasi, suggest reasons why there were not more injuries or greater loss of life.

PREDICT

6 Use the **Yasi animated loop** weblinks in the Resources tab to watch the rainfall radar loop of Cyclone Yasi. Imagine you are reporting this event on the evening news. Use the key on the map to help you describe the rainfall intensity and how it ***changed*** over the days shown. Use the information in this section and previous sections to explain how the wind would have ***changed*** in both speed and direction. Explain the ***interconnection*** between the ***changes*** in wind and rainfall and the resulting damage.

APPLY

7 Below are the average rainfall figures for Innisfail and Cardwell. Both are located within 50 kilometres of the towns with the highest rainfall totals during Cyclone Yasi. The table reflects the rainfall totals averaged over at least 30 years of data.
- **a** Construct bar graphs to represent these figures. Refer to the SkillBuilder 'Creating a simple column or bar graph' in subtopic 15.6 to help you.
- **b** Describe the distribution of rainfall in both Cardwell and Innisfail. Make reference to the months and seasons of the year in your answer.
- **c** Suggest why rainfall is much higher in the first three months of the year than in mid-year months.
- **d** Compare the rainfall figures in table 1 in this subtopic with the January figures in your graph. Drawing a bar graph to represent these figures might help you make your comparison.
- **e** Why do you think nearly a month's rainfall occurred in such a short space of time?

TABLE 2 Cardwell

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	YEAR
Mean rainfall (mm) for years 1871 to 2016	438.5	465.9	400	208.6	94.7	47	32.4	29.2	38.5	54.4	115.2	193.5	2111.9	139

TABLE 3 Innisfail

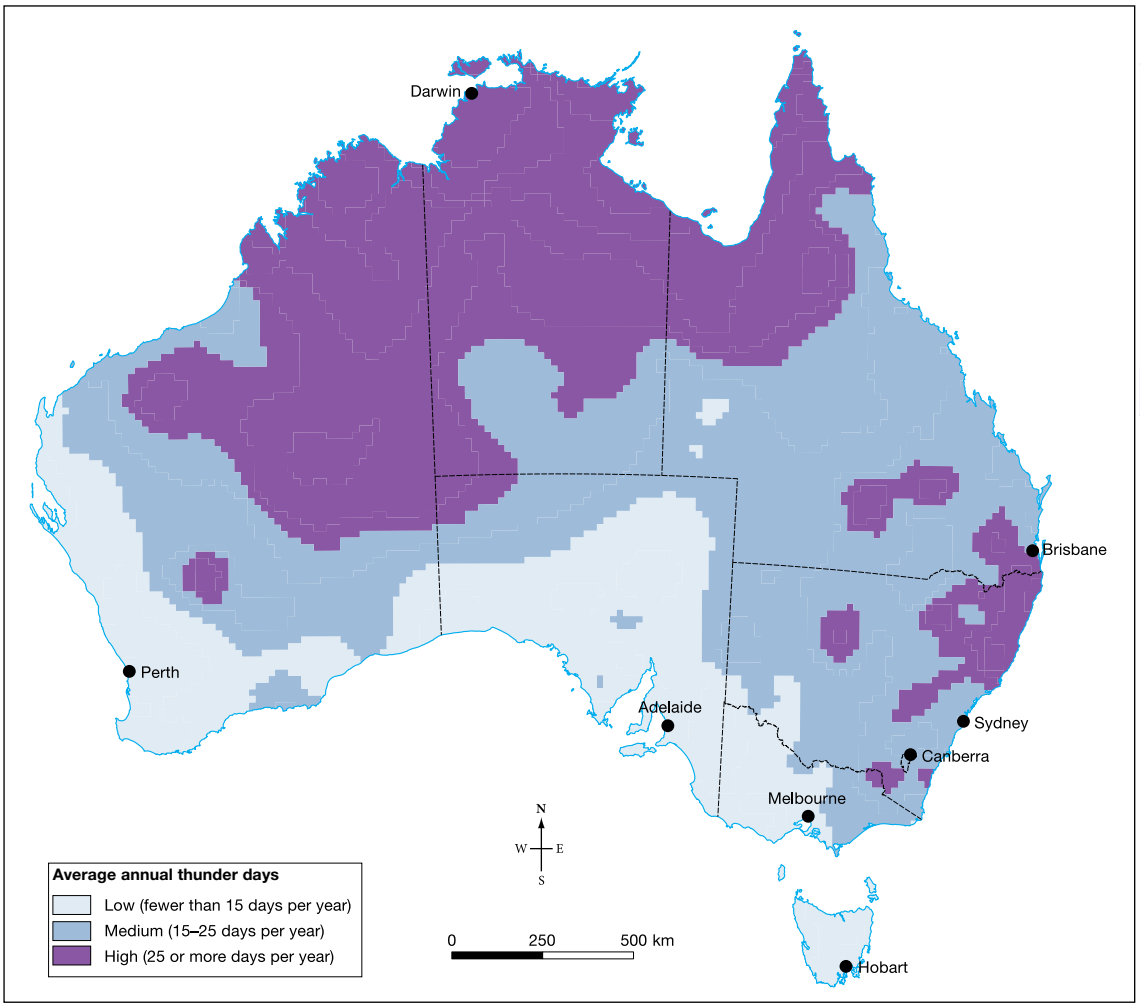
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	YEAR
Mean rainfall (mm) for years 1881 to 2016	507.3	590.1	662.2	456.3	299.5	302.2	189	137.6	116.9	86.1	87.7	157.9	262.6	3558.1

15.16 Review

15.16.1 Review

1. Why do winds vary in strength?
2. What is the difference between a tornado and a cyclone?
3. Study figure 1 and answer the following questions.
   a. Which capital cities are more likely to have severe thunderstorms?
   b. Which parts of Australia are least likely to have severe thunderstorms?

FIGURE 1 Average annual thunder days, Australia



Source: Spatial Vision

4. Study figure 2 and answer the following questions.
   a. Calculate the number of cyclones that occurred between 1990 and 2011.
   b. How many of these were classified as (i) severe and (ii) non-severe?
   c. Describe the overall trend shown in the graph.

5. Where do most of the world's tornadoes occur?
6. Three separate tornadoes touched down in Suffolk, Virginia, injuring 200 people. One of the twisters threw this vehicle (figure 3) through the window of a medical centre. Explain why tornadoes can cause this type of damage.
7. a. What is a wind rose and why is it useful?
   b. The wind rose sequence shown in figure 4 is from Adelaide, and it reflects a compilation of data collected over the last 15 years at least. Describe how Adelaide's winds ***change*** seasonally. Make reference to both wind speed and direction.
8. Cyclones, thunderstorms and blizzards have something in common: strong winds and water. Select one of these hazards and describe the impact of wind and water on both the human and built ***environment***. Refer to the ***scale*** of such events. Explain why water is a key element in your chosen hazard.

FIGURE 2 Tropical cyclone frequency, 1990 to 2011

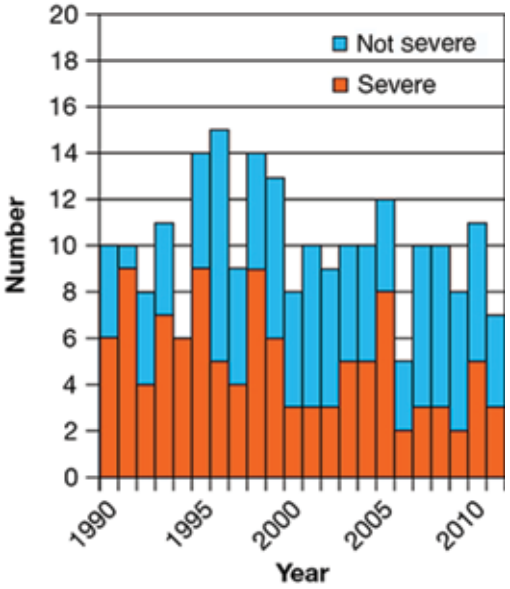


FIGURE 3 Damage caused by a tornado in Suffolk, Virginia, United States

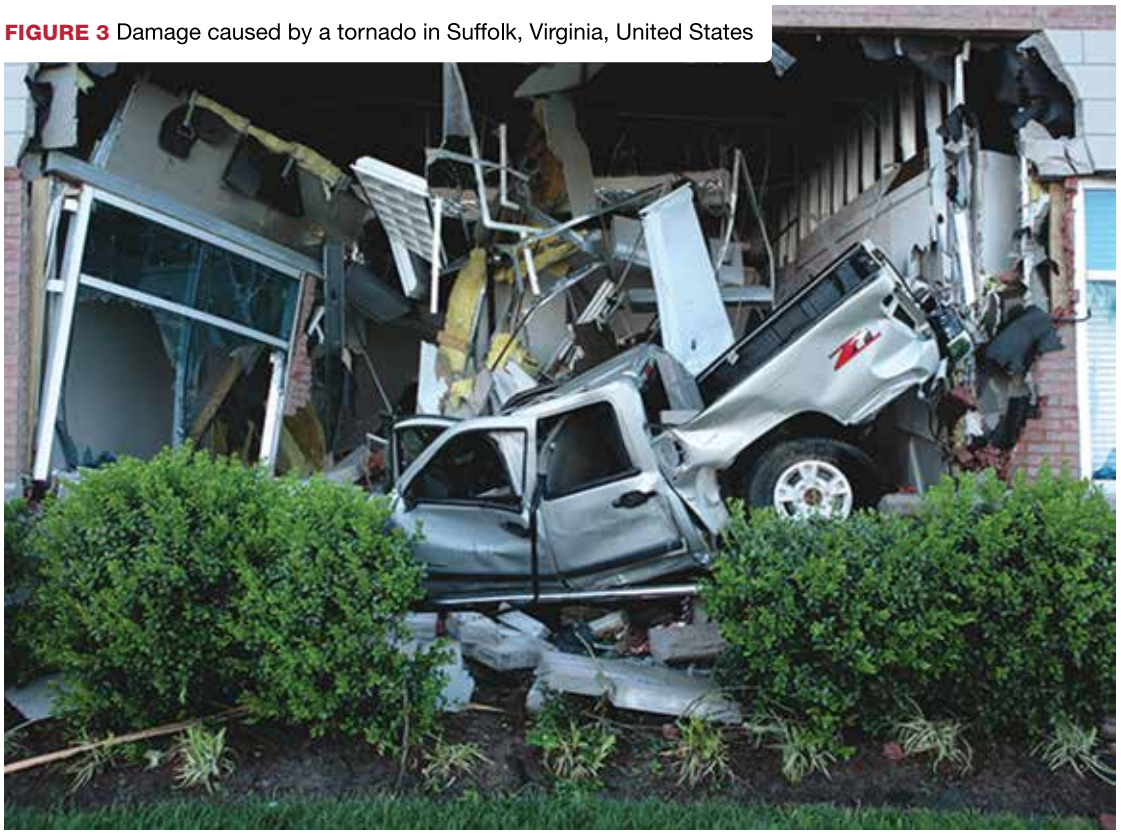
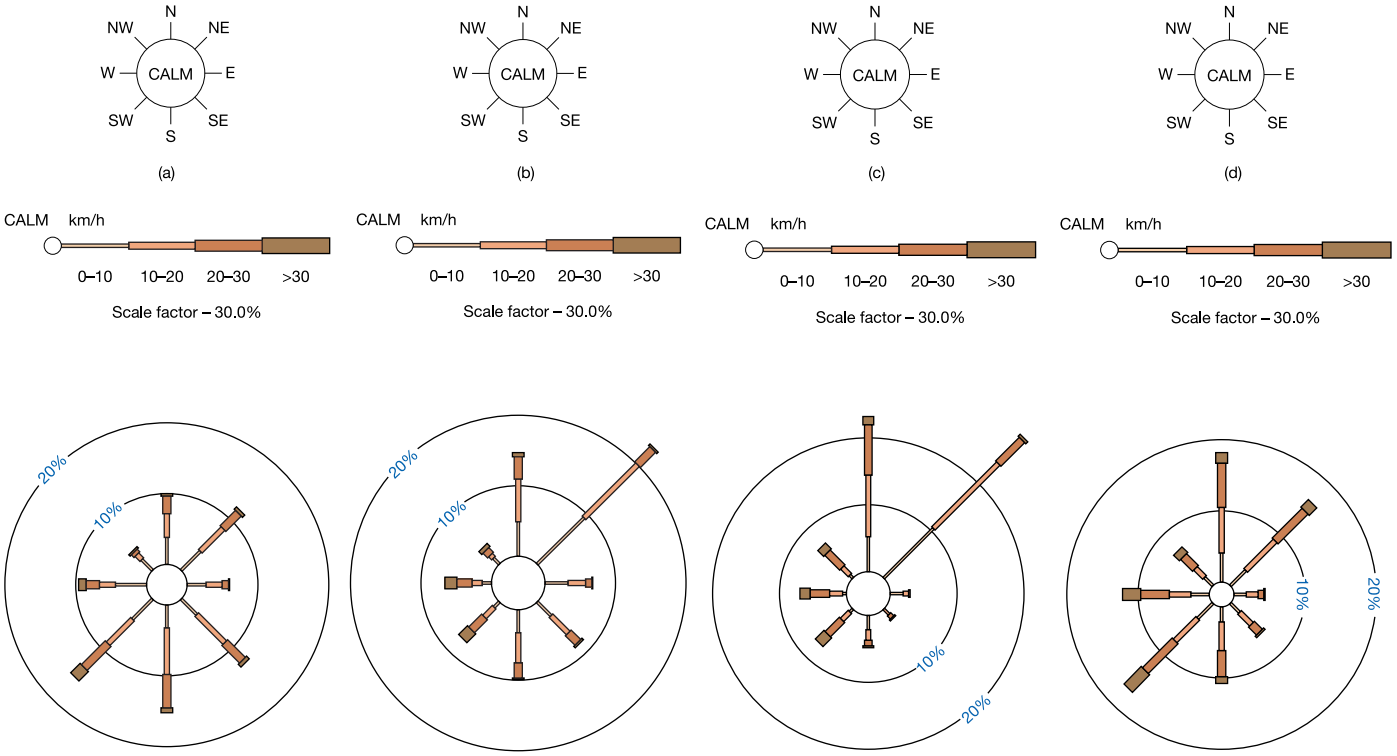


FIGURE 4 (a) Wind rose for Adelaide, summer (b) Wind rose for Adelaide, autumn (c) Wind rose for Adelaide, winter (d) Wind rose for Adelaide, spring



15.16.2 Reflect

It's all in the wind

As the population increases and our power needs increase, wind power could hold the key to providing for our future needs. In October 2010, Australia had 52 wind farms comprising 1052 wind turbines — enough to provide two per cent of the nation's energy needs (700 000 homes). By 2015 Australia had 76 wind farms, made up of 2062 turbines. The ultimate aim is for wind power to eventually generate at least 20 per cent of Australia's power needs.

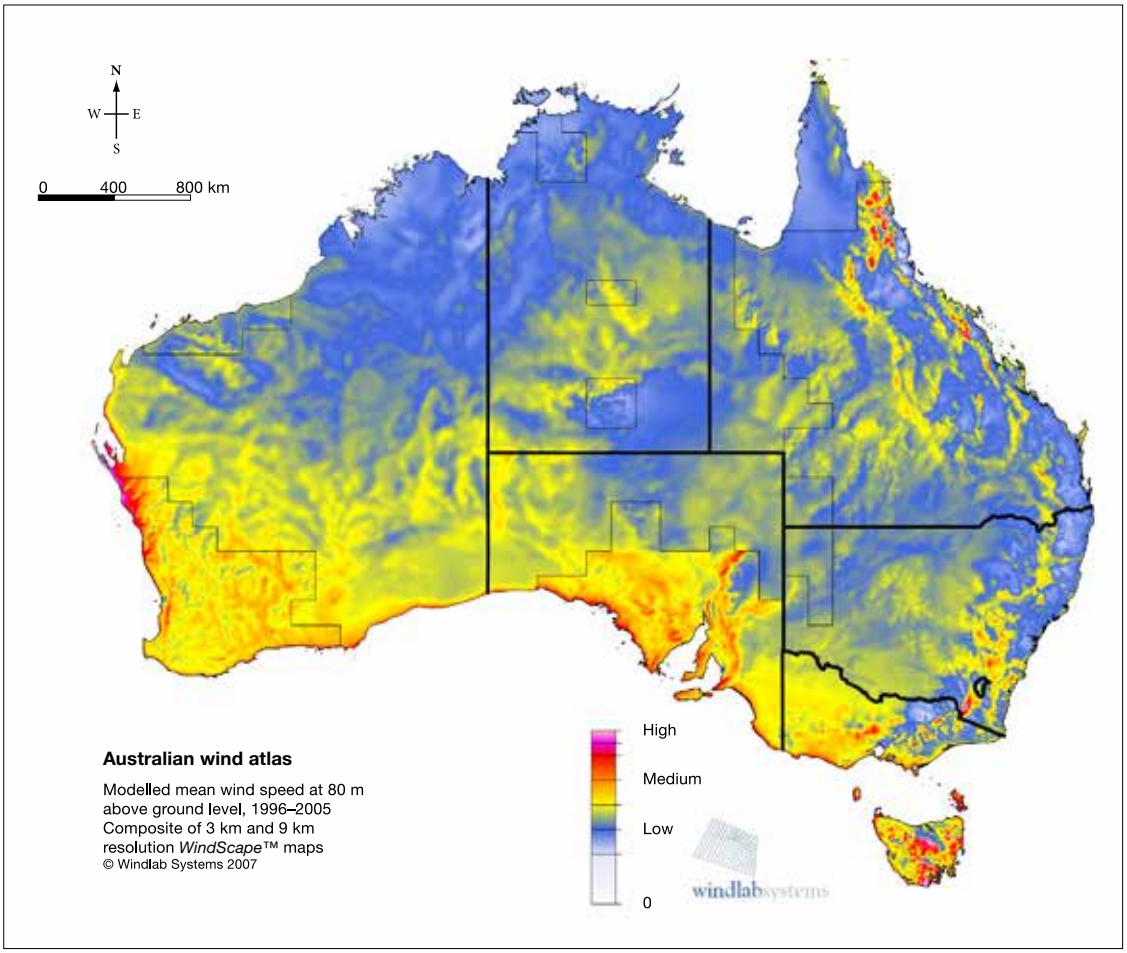
Wind power is a renewable, reliable, green and sustainable source of energy. However, wind farms have not been without controversy. Environmentalists have raised concerns about low-frequency noise and the risk that turbines pose to birds. Many scientists say that these are not real problems, but people living near wind farms are not always convinced. Wind farms appear to be compatible with agriculture.

In terms of generating capacity, Australia ranks fifteenth in the world. The top five countries worldwide are China, the United States, Germany, Spain and India.

For example, the Emu Downs wind farm, 200 kilometres north of Perth in Western Australia, comprises 48 turbines and provides enough energy to power the Kwinana desalination plant south of Perth. Here, 150 million litres of drinking water are produced daily from the waters of the Indian Ocean.

The Waubra wind farm, north-west of Ballarat in Victoria, consists of 128 wind turbines and generates more than enough energy to meet the needs of Ballarat.

FIGURE 5 Wind generation in Australia. Wind potential is indicated in red; the deeper the red the greater the capacity of an area for wind generation. Areas shaded in blue and yellow have less capacity for continuous wind generation.

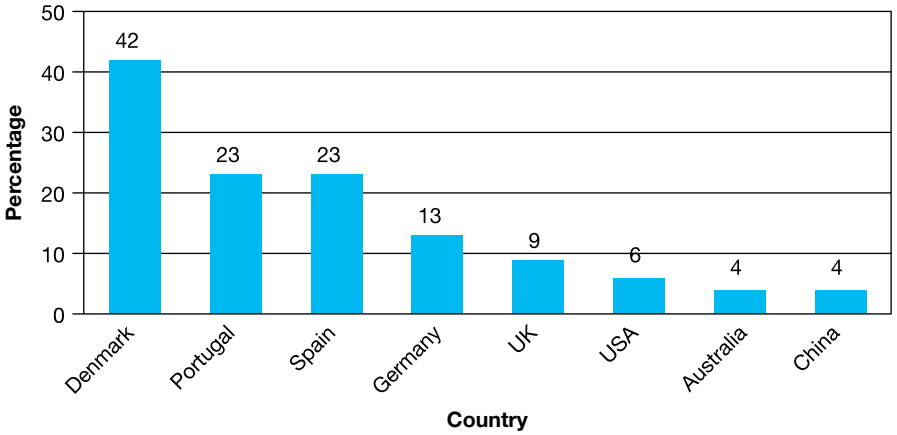


Source: Spatial Vision

FIGURE 6 A wind farm



FIGURE 7 Percentage of energy generated by wind farms



9. Why do you think many countries are now looking to wind power to meet their energy needs?
10. Refer to the map in figure 5, and describe the areas most suited to wind farms.
11. Calculate the number of wind turbines needed and the number of homes that would be powered when the number of wind farms doubles from 52 to 104.
12. If the ultimate aim is to provide 20 per cent of Australia's power needs, estimate the number of wind turbines that will need to be constructed to meet this target.
13. Why do you think farmers would be keen to install wind turbines?

CHAPTER 16

Fieldwork inquiry: What is the water quality of my local catchment?

16.1 Overview

16.1.1 Scenario and task

Task: Produce a report and presentation about the water quality of a local catchment or waterway.

Water is our most valuable resource, and the management of this vital resource should be a priority at a local, regional and global scale. Everybody lives near a catchment — there is usually a river, creek, drain or other waterway close to your home, school or neighbourhood. If you live in an urban area, the creek may have been highly modified and may look like a concrete drain. Water quality in these waterways will vary from place to place and is influenced by many factors.

Water quality can affect health in many ways. Rivers and streams act as drainage systems. When it rains, water transports rubbish, chemicals and other waste into drains and, eventually, rivers.

Your task

Your team has been selected to research the water quality of a local catchment or waterway and produce a report and presentation on your findings. Be sure to measure water quality at different locations along the river, creek or stream, and try to determine the causes of different water quality.



16.2 Inquiry process

16.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You can complete this project individually or invite members of your class to form a group. Save your settings and the project will be launched.

- **Planning:** Navigate to your Research Forum. You will need to research the characteristics of your local catchment area. In order to complete sufficient research, you will need to visit a number of sites within the catchment, comparing different locations upstream and downstream of one creek or river. Research topics have been loaded in the system to provide a framework for your research:
  - **What** sort of data and information will you need to study water quality at your fieldwork sites?
  - **How** will you collect and record this information?
  - **Where** would be the best locations to obtain data? You can determine this once you know which waterway(s) you are visiting.
  - **How** will you record the information you are collecting? Consider using GPS, video recorders, cameras and mobile devices (laptop computer, tablet, mobile phone).

16.2.2 Collecting and recording data

It is important that you have some knowledge of the fieldwork location before you visit the site. Access to topographic maps and Google Earth will help you become familiar with the location. Using these tools, complete a sketch map of the waterway(s) and label the sites you are going to visit. You can then scan your sketch map and have it available electronically on the field trip. Alternatively, use Google Maps to record all the sites you visit. Ensure that you bring all the equipment and resources you will need to collect the data with you to each site. It would be useful to work in groups to collect the data, with each group collecting different data at each site. Use the supplied data collection templates electronically on your mobile device, or print copies.



16.2.3 Processing and analysing your information and data

Once you have collected, collated and shared your data, you will need to decide what information to include in your report and the most appropriate way to show your findings. If using spreadsheet data, make total and percentage calculations. Some measurements are best presented in a table, others in graphs or on maps. If you have used a spreadsheet, you may like to produce your graphs electronically. Use photographs as map annotations (either scanned and attached to your electronic map or attached to your hand-drawn map) to show features recorded at each site. You may also like to annotate each photograph to show the geographical features you observed. Describing and interpreting your data is important. There are broad descriptions that can also be made of your findings, which might include the following.

- Where is water quality highest (best) in the waterway studied?
- Is water quality better in the upper reaches of the river or creek?
- Does an urban waterway have better water quality than a rural waterway?
- Does surrounding land use have an impact on water quality?
- Do large waterways have better water quality than smaller waterways?
- What were the main contributors to poor and good water quality?
- How does surrounding vegetation impact on water quality?

Visit your Media Centre and download the report template and the presentation planning template to help you complete this project. Your Media Centre also includes images, videos and audio files to help bring your presentation to life. Use the report template to create your report. Use the presentation template to create an engaging presentation that showcases all of your important findings.

16.2.4 Communicating your findings

You will now produce a fieldwork report and presentation to present your findings. Your report and presentation should include all of the research that you completed and all evidence to support your findings. Ensure that your report includes a title, an aim, a hypothesis (what you think you will find, which is written before you go into the field), your findings and a conclusion. You will also need to recommend some type of action that needs to be taken to improve water quality in the creek or river you visited.

16.3 Review

16.3.1 Reflecting on your work

Think back over how well you worked with your group on the various tasks for this inquiry. Determine strengths and weaknesses and recommend changes if you were to repeat the exercise. Identify one area where you were pleased with your performance, and an area where you would like to improve. Write two sentences outlining how you might be able to do this.

Print out your Research Report from ProjectsPLUS and hand it in with your fieldwork report and presentation, and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

Suggested software

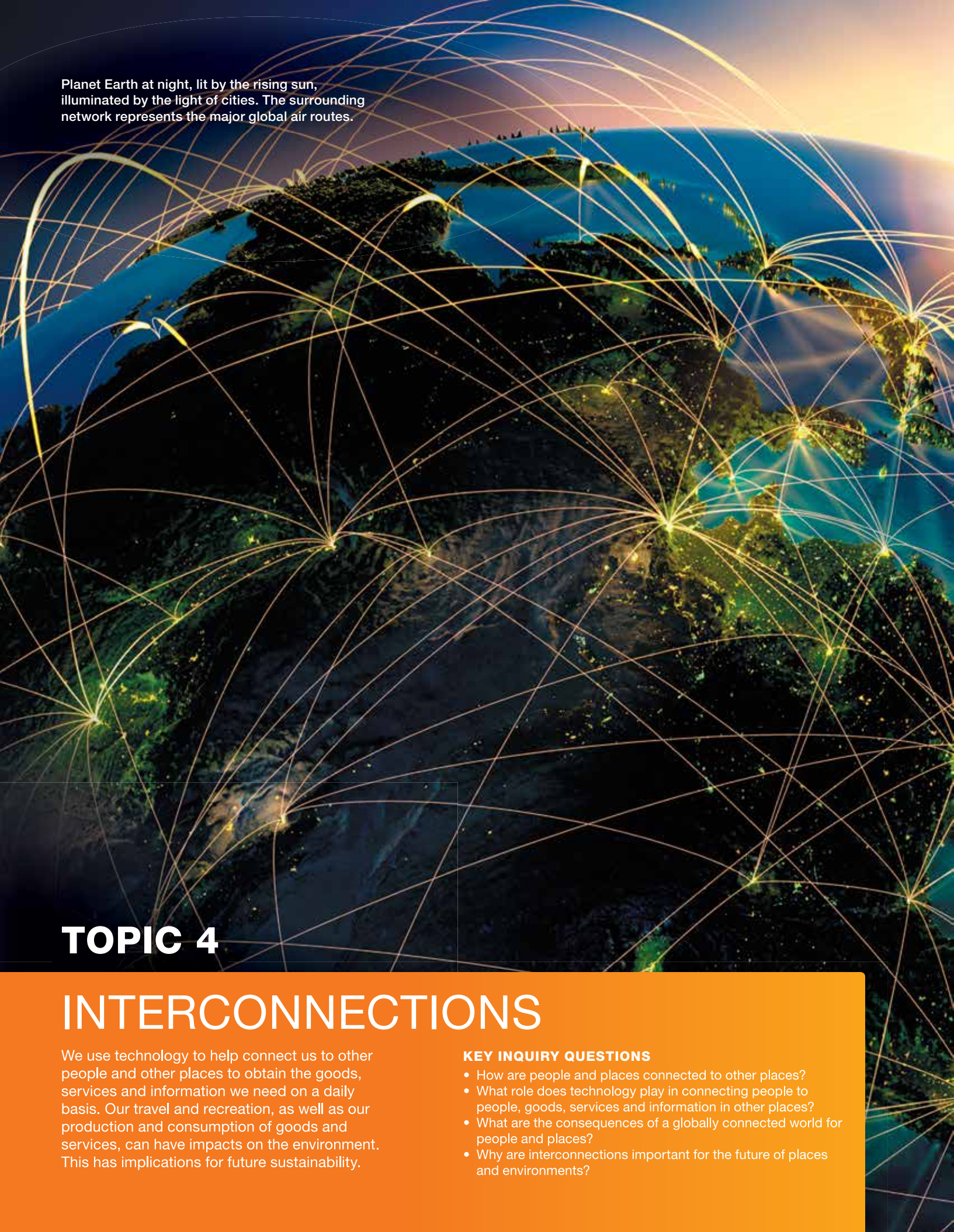
- ProjectsPLUS
- Microsoft Word or any other word processing tool
- PowerPoint or any other presentation tool

Media centre

Your Media Centre contains:

- fieldwork data recording templates
- a report template
- a presentation template
- a selection of images and audio and video files to add richness to your presentation
- weblinks to sites to assist in your catchment research and to provide sample presentations
- an assessment rubric.





Planet Earth at night, lit by the rising sun, illuminated by the light of cities. The surrounding network represents the major global air routes.

TOPIC 4

INTERCONNECTIONS

We use technology to help connect us to other people and other places to obtain the goods, services and information we need on a daily basis. Our travel and recreation, as well as our production and consumption of goods and services, can have impacts on the environment. This has implications for future sustainability.

KEY INQUIRY QUESTIONS

- How are people and places connected to other places?
- What role does technology play in connecting people to people, goods, services and information in other places?
- What are the consequences of a globally connected world for people and places?
- Why are interconnections important for the future of places and environments?





People move to and from many different places for many different reasons.

CHAPTER 17

Personal connections

17.1 Overview

17.1.1 Introduction

The World Tourism Organization estimates that by 2030, five million people will move each day. Where will these people go and what will influence their choices? What impact will these choices have on the places they visit?

Starter question

1 Explain how tourism ***interconnects*** people and ***places***.

Inquiry sequence

		Syllabus outcomes
17.1 Overview		
17.2 Why do we travel?		GE4-2, GE4-3, GE4-4
17.3 Travel patterns		GE4-2, GE4-3, GE4-4
17.4 SkillBuilder: Constructing and describing a doughnut chart	eBook*plus* ONLINE ONLY	GE4-2, GE4-3, GE4-4
17.5 Sport, recreation and leisure		GE4-2, GE4-3, GE4-4, GE4-5
17.6 Cultural tourism		GE4-2, GE4-3, GE4-4, GE4-5
17.7 Impacts of travel		GE4-2, GE4-3, GE4-4, GE4-5
17.8 SkillBuilder: Creating a survey	eBook*plus* ONLINE ONLY	GE4-2, GE4-3, GE4-4, GE4-5
17.9 SkillBuilder: Describing divergence graphs	eBook*plus* ONLINE ONLY	GE4-2, GE4-3 GE4-4, GE4-5
17.10 Future trends and sustainability		GE4-4, GE4-5
17.11 Sustainability and ecotourism		GE4-4, GE4-5
17.12 Investigating topographic maps: How does nature drive tourism in Victoria Falls?		GE4-2, GE4-3, GE4-4, GE4-5
17.13 Review	eBook*plus* ONLINE ONLY	
Key terms	eBook*plus* ONLINE ONLY	





eBook*plus*

Watch this video
Moving around
Searchlight ID: eles-1723

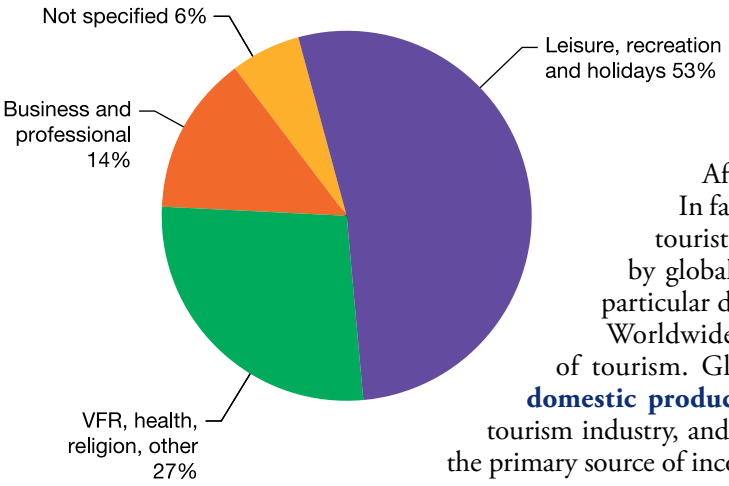
PEOPLE & PLACES

17.2 Why do we travel?

17.2.1 What is tourism and why is tourism important?

Travel is the movement between places, often a journey between distant geographical locations. Tourism is the temporary movement of people away from the places where they normally work and live. This movement can be for business, leisure or cultural purposes (see figure 1), and it involves a stay of more than 24 hours but less than one year.

FIGURE 1 Purpose of people's travel, 2014



gross domestic product (GDP) the value of all the goods and services produced within a country in a given period of time. It is often used as an indicator of a country's wealth.

Global tourism is expected to increase by 3.3 per cent a year between 2010 and 2030 to reach 1.8 billion by 2030. This is despite global economic issues, political change in the Middle East and Africa, and a range of natural disasters. In fact, some of the world's most popular tourist destinations were those affected by global concerns. Figure 2 illustrates why particular destinations are popular.

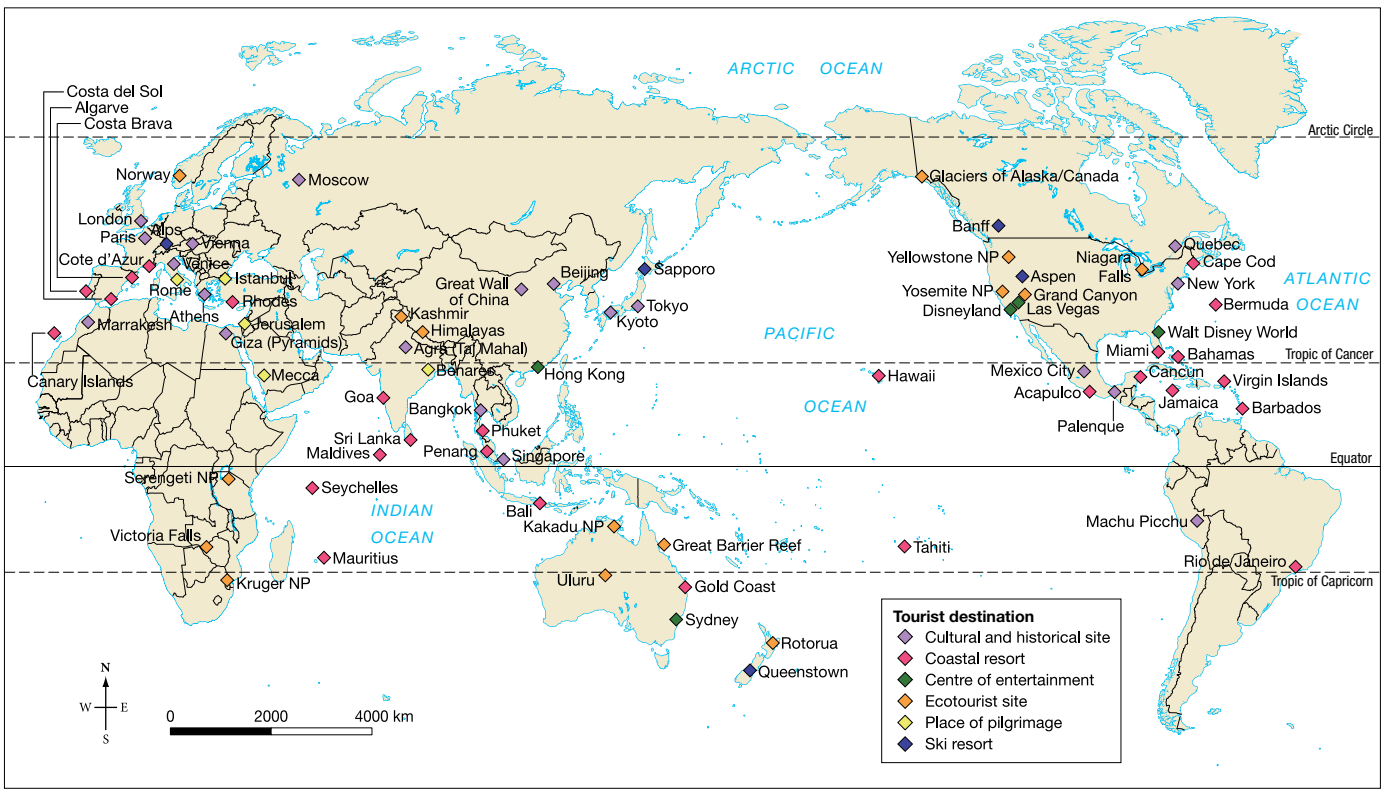
Worldwide, 308 million jobs exist because of tourism. Globally, around six per cent **gross domestic product (GDP)** is directly linked to the tourism industry, and for many developing countries it is the primary source of income.

17.2.2 Why is tourism increasing?

Tourism has increased dramatically over the last 50 years and continues to grow. Advances in transport technology have reduced not only travel times but also cost.

- Today, you can fly from Australia to Europe in around 20 hours, whereas 40 years ago the same journey took six weeks by boat.

FIGURE 2 Types of tourist destinations



Source: Spatial Vision

FIGURE 3 Four kinds of tourist — are all tourists the same?



Organised mass tourist
- Least adventurous
- Purchases a package with a fixed itinerary
- Does not venture from the hotel complex alone; is divorced from the local community
- Makes few decisions about the holiday

Individual mass tourist
- Similar to the organised mass tourist and generally purchases a package
- Maintains some control over their itinerary
- Uses accommodation as a base and may take side tours or hire a car

The explorer
- Arranges their own trip
- May go off the beaten track but still wants comfortable accommodation
- Is motivated to associate with local communities and may try to speak the local language

The drifter
- Identifies with local community and may live and work within it
- Shuns contact with tourists and tourist hotspots
- Takes risks in seeking out new experiences, cultures and places

- Today, airline and tour companies offer a range of cut-price deals, and the increased number of competitors for the tourist dollar means that travel is more affordable.
- Increased awareness and knowledge of the world has sparked people's desire to see new places and experience different cultures.
- In general, the travelling public has more leisure time and more disposable income, making both domestic and international travel viable.

17.2.3 What are the latest trends in tourism?

Tourism is an important component in world economies. One in 12 jobs worldwide is linked either directly or indirectly to the tourism industry. In the first part of the twenty-first century, this industry grew by almost 45 per cent, from 674 million international arrivals in 2000 to 1134 million in 2014. It is predicted that this figure will rise to 1.6 billion in the year 2020 (see figure 4).

Tourists added US$1245 billion to the global economy in 2014 — almost twice the expenditure of the year 2000.

17.2.4 Factors shaping the future of tourism

Tourism is no longer just for the elite. Improvements in transport and technology have increased our awareness of the world around us. Improved living standards, increased leisure and greater disposable incomes have all created opportunities for people to travel and to experience new places and cultures. These factors are also shaping the tourist of the future (see figure 5). A particular growth area is the 18–35 market — young people travelling while studying, taking a break from study, or seeing the world before they settle down. The other major area of growth is the over-60 age bracket.

FIGURE 4 Contribution of tourism to the world economy





FIGURE 5 Factors shaping the future of tourism

Predictions also suggest that Africa and the Asia–Pacific region will be particular growth areas, attracting more and more of the tourist dollar.

Countries such as Kenya and Tanzania offer a different type of tourist experience. Kenya, for instance, offers:

- safety
- beaches and a tropical climate
- safari parks and encounters with lions and elephants
- a unique tribal cultural experience with the **Maasai** people.

Maasai an ethnic group of semi-nomadic people living in Kenya and Tanzania

The resulting influx of tourists to Kenya has led to the establishment of **national parks** to protect endangered wildlife and promote this aspect of the tourism experience. Money flowing into the region helps improve water quality and infrastructure such as water pipes, roads and airports.

national parks a park or reserve set aside for conservation purposes

The true challenge for the future, however, is to ensure that:

- money remains in the local economy rather than in the hands of developers, and is used to improve local services, not just tourist services
- the need of indigenous tribes to farm the land is balanced with tourist development
- tourist numbers are controlled, to ensure that the environment is not damaged.

17.2.5 Medical tourism

Medical tourism involves people travelling to overseas destinations for medical care and procedures. The low cost of travel, advances in technology and lengthy waiting lists caused by increased demand for elective surgery are turning medical tourism into a multi-billion dollar industry.

Medical tourism only used to be for cosmetic procedures, such as face-lifts and tummy tucks, but the range of services offered has expanded dramatically over recent years. It now includes:

- knee replacements
- hip replacements
- fertility treatments (IVF)
- surrogacy services, and
- complex heart surgery.

Countries all over the world are attracting patients for a variety of reasons, which include:

- the high standard of medical care or the
- outstanding reputation of particular facilities
- savings on the cost
- reduced or no waiting time
- the opportunity to include a holiday and luxury accommodation as part of the package.

Asia is the market leader in the medical tourism industry, with Thailand and India

FIGURE 6 Cost savings that can be made by having medical treatment in Asia versus Australia

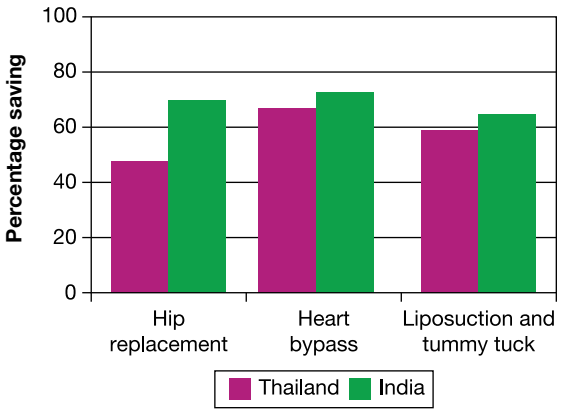
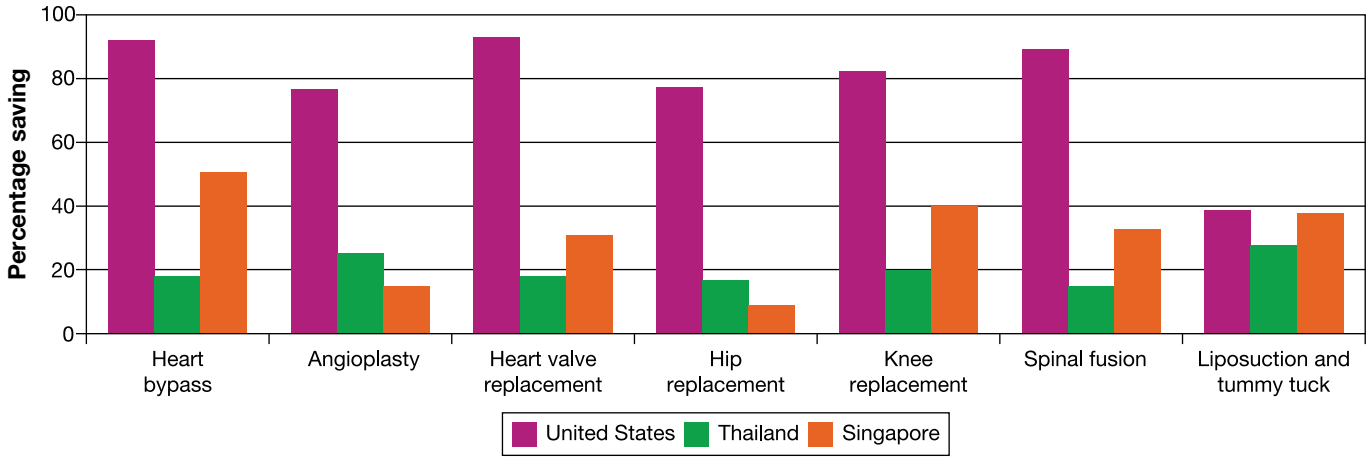


FIGURE 7 Cost savings that can be made by having medical procedures carried out in Malaysia versus the United States, Thailand or Singapore



vying for the number one spot. Thailand is slightly more expensive, but offers a better tourist experience and has greater services available. India is less expensive and boasts state-of-the-art facilities staffed by Western medical staff, predominantly from the United States. Figures 6 and 7 show the savings made between developed and developing countries. Medical tourism is expected to add more than US$8.5 billion to Asian economies this year.

GEOskills TOOLBOX

Linear scale

Many graphs such as the column graphs in figures 6 and 7 will use a linear (or line) scale. This means the values (for example percentages, dollars or years) change in equal increments. This makes it easy to see the differences between different categories.

ACTIVITIES

IDENTIFY

1 What is a tourist?
2 Why do you think tourism is one of the fastest growing industries?

EXPLAIN

3 Using your atlas as a primary source of information, select three ***places*** from different categories shown in figure 2 that you might like to visit.
   a Calculate the distance between them.
   b Explain how you would travel to each.
   c Explain what you might expect to see and do in each ***place***.
   d Work out how long it might take to visit each ***place***.
   e Describe each location using geographical concepts such as latitude and longitude, direction and ***scale***.
   f Explain why you have chosen each ***place***.

INVESTIGATE

4 What type of tourist are you? Make a sketch of yourself, similar to the one shown below.



Annotate your cartoon to describe yourself as a tourist, using information in this section to help you. Include information about your ideal holiday and explain why you appear as you do in your cartoon.

APPLY

5 In 2014, 1133 million tourist movements were recorded globally. How many movements is this per day?
6 a Using information in this section, predict how many tourists there will be in 2020. What percentage increase does this represent?
   b Which ***places*** do you think will be the most popular?
   c What impact do you think these increases will have on the ***environment***?
   d Will this result in small-***scale*** or large-***scale change***?
   e Do you think these numbers are ***sustainable***? Explain.
7 Tourism expenditure increased by 160 per cent between the year 2000 and the year 2014, from $475 billion to $1245 billion. Using these figures as a guide, predict how much income might be generated through tourism by 2030.
8 Look back over your responses to the last three questions. What does this tell you about the importance of tourism? Explain.
9 a Explain what you understand by the term *sustainable tourism*.
   b Describe an example of tourism that would be considered ***sustainable***.
   c Describe an example of tourism that would not be considered ***sustainable***. Suggest what ***changes*** might be needed to make it ***sustainable***.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› World tourism
› Victoria Falls

17.3 Travel patterns

17.3.1 Why is global tourism on the rise?

Tourism is one of the world's largest industries. Even when global economies are experiencing a downturn, people still travel. After natural disasters, countries rely on the return of the tourist dollar to help stimulate their economies. However, the spread of tourism is not uniform across the globe.

FIGURE 1 Backpackers spend more, travel further and stay longer than other tourists.



Over time, travel has become faster, easier, cheaper and safer. Economic growth has meant that many now have more money to spend and can afford to travel. Increases in annual leave have provided people with more time to travel. For example, Australians and New Zealanders can take long-service leave, which is often spent on an extended overseas trip. It has also become more fashionable for young people to spend time seeing the world during their 'gap year' and to travel before commencing **tertiary study**, establishing a career and raising a family (see figure 1).

tertiary study the educational level following the completion of high school, e.g. university

mature-aged describes individuals aged over 55

developed describes countries with a highly developed industrial sector, a high standard of living, and a large proportion of people living in urban areas

Many young travellers see backpacking as the optimum way to travel. Generally this group:

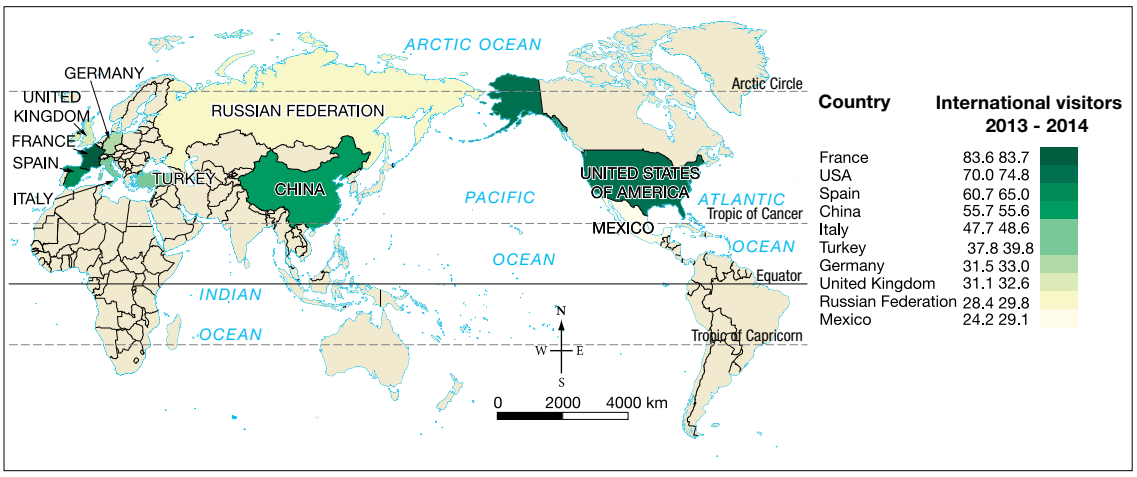
- is on a tight budget
- wants to mix with other young travellers and local communities
- has a flexible itinerary
- seeks adventure
- is prepared to work while on holiday to extend their stay.

At the other end of the scale, there has also been a dramatic growth in **mature-aged** tourist movements. The number of older people in **developed** countries is growing. In many instances, they have older children who are no longer dependent on their parents for support. Some of these travellers have savings, access to superannuation funds, and the opportunity to retire early; thus, they have both the time and the money to travel.

17.3.2 What countries are top 10 destinations?

As each tourist enters or leaves a country, they are counted by that country's customs and immigration officials. This data is collected by the World Tourism Organization, and the results can be shown spatially (see figure 2).

FIGURE 2 World's top 10 tourist destinations



Source: World Tourism Organization (UNWTO)

17.3.3 Who spends the most?

Figure 2 shows the countries that attract the most tourists, but which countries do these tourists come from, and what do they spend? Figure 3 shows the top 10 countries in terms of the money they spend on international tourism. Figure 4 shows the per capita expenditure of the world's top 10 tourist spenders.

FIGURE 3 World's top 10 tourist spenders by expenditure

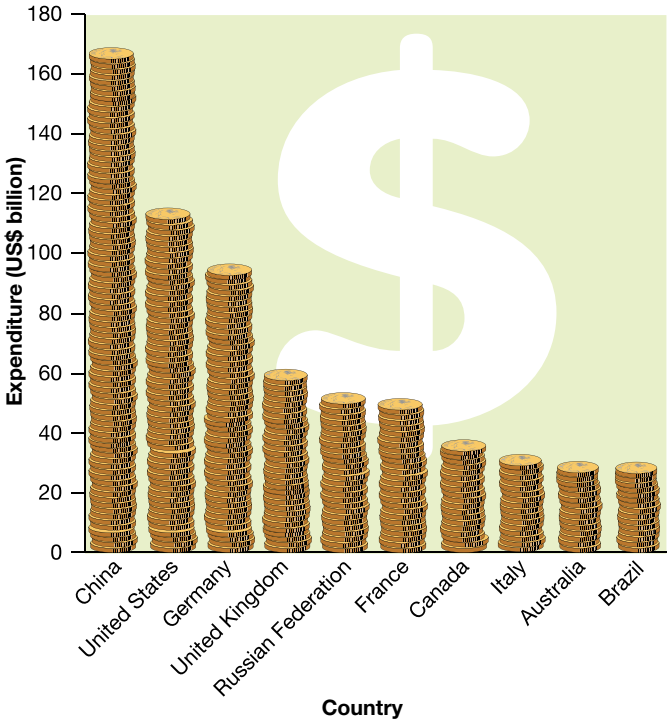
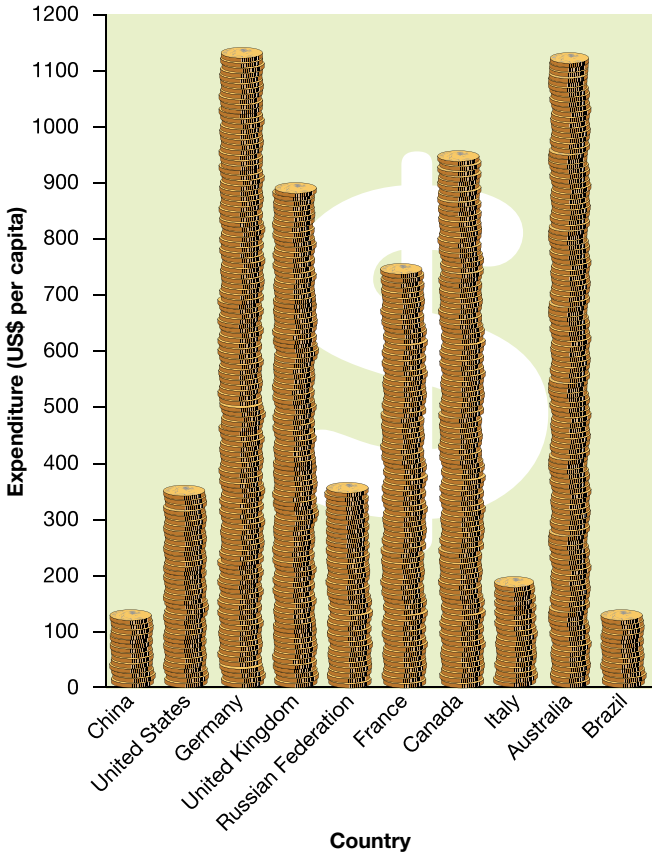


FIGURE 4 World's top 10 tourist spenders per capita



17.3.4 Where do people stay?

The growth of home sharing sites such as Airbnb has enabled people to have a more authentic experience of another culture by allowing tourists to stay in local homes rather than in hotels. Many people use these sites to let out their own homes to other tourists while they themselves are on holiday, therefore engaging in a form of house swapping.

TABLE 1 World's top 5 hotel owners, 2014

Company	Headquarters (country)	Total hotels	Total rooms
Intercontinental Hotels Group	UK	4967	686 876
Hilton Worldwide	USA	4115	678 630
Marriott International	USA	3783	653 719
Wyndham Worldwide	USA	7485	645 423
Choice Hotels	USA	6303	602 663

The growth of Airbnb has been huge. In 2010, there were roughly 50 000 stays in the northern hemisphere summer. By 2015, this had increased to 17 million. While this growth is significant it has not meant that people no longer stay in hotels. Many hotels are now repositioning themselves with new boutique hotels to take advantage of 'ageless millennials'. These are people who are aged between 40 and 70 and have adopted the love of technology, trends and social media, usually associated with 'millennials', to communicate.

ACTIVITIES

EXPLAIN

1 Carefully study figures 2 and 3 and answer the following.
- **a** On which continents are the top 10 destinations located?
- **b** Which continents are generating the most in tourism spending?
- **c** Describe the ***interconnection*** between destinations and tourism spending.

2 What is the difference between a mature-age tourist and a backpacker? With the aid of a Venn diagram, show the differences in the needs of these two groups of tourists.

INVESTIGATE

3 The three main types of tourist attraction are natural, cultural and event attractions. Use a dictionary to help you write your own definition of each term. For each of the countries shown in figure 2, try to find an example of each type of attraction. Use the map in figure 2, section 17.2, to help you.

PREDICT

4 a On a blank outline map of the world, locate and label the capital cities of each of the top 10 tourist destinations.
- **b** Plot a trip from your nearest capital city to all 10 of these ***places***, covering the shortest possible distance, and returning to your capital city. Use the ***scale*** on the map to estimate the distance travelled.
- **c** Calculate the time it might take to complete this journey.

5 a Find out the average cost of a one-week stay in one of the hotel chains shown in table 1.
- **b** How much income would this room generate if it was occupied for each night of the year?

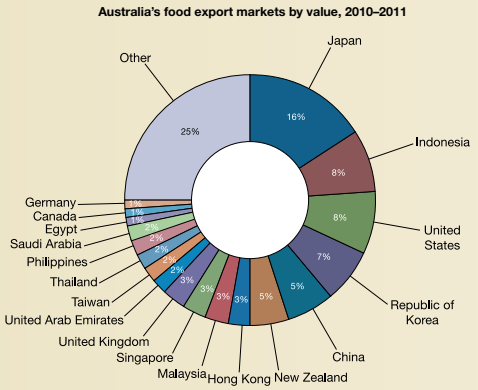
6 a What are the advantages/disadvantages of using a room- or house-sharing site such as Airbnb?
- **b** What would be the advantages/disadvantages of using this service to the local community in which this accommodation is situated?

eBook*plus* ONLINE ONLY

17.4 SkillBuilder: Constructing and describing a doughnut chart

What is a doughnut chart?

A doughnut chart is a circular chart with a hole in the middle. Each part of the doughnut is divided as if it were a pie chart with a cut-out. Presenting the parts in order from largest to smallest makes it easy to interpret.



eLesson

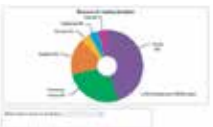
Watch this video to learn how to construct and describe a doughnut chart.



Searchlight ID: eles-1738

Interactivity

Try this interactivity to learn how to construct and describe a doughnut chart.



Searchlight ID: int-3356

17.5 Sport, recreation and leisure

17.5.1 How are tourism and sport connected?

Sport tourism involves people travelling to view or participate in a sporting event. It is an expanding sector of the tourism industry, currently adding $700 billion to global economies each year. It is estimated that, on average, 12 million international trips are made to view sporting events. But what impact does this have on people and places?

Governments spend millions of dollars to attract people to sporting events such as the Olympics, the cricket, soccer and rugby world cups, and motor racing events, to name just a few. These events also trigger:

- construction of new stadiums
- expansion and upgrades of transport networks
- improvements to airport facilities
- clean-ups of cities in readiness for the arrival of tourists.

Sports tourists fall into two broad categories: those who like to watch and those who want to participate. The latter view sport as a part of their leisure and recreational activities (see figure 1). A common trait in all sports tourists is their passion and willingness to spend money to induge this passion.

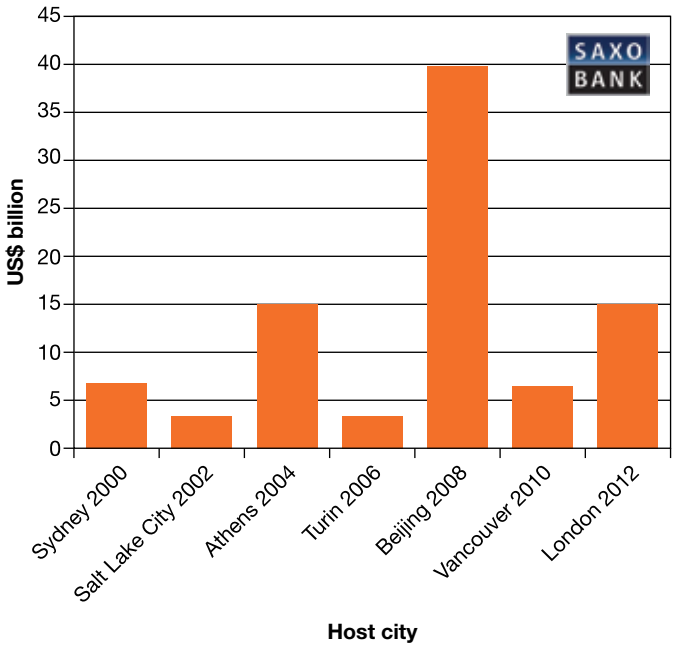
FIGURE 1 On the course — recreational tourism



17.5.2 Are the Olympics a tourist bonanza?

Major sporting events such as the Olympics translate into improved infrastructure, and provide the host city with considerable international exposure. Does this bring in more tourists and justify the capital outlay? (See figure 2.)

FIGURE 2 Olympics expenditure (both summer and winter games), including infrastructure



Source: Saxo Bank

The general consensus is that the costs associated with hosting a one-off major event, such as the soccer World Cup or the Olympic Games, do not meet the anticipated outcomes. Statistics show that three million tourists visited the United Kingdom in August 2012 (their Olympic year) — five per cent *less* than in the previous year. Tourism spending, however, went up by nine per cent, in part because of spending on Olympic tickets. In addition, many UK residents chose to holiday overseas rather than remain at home during the Olympic Games. Organisers were also frustrated by the number of empty seats in many of the venues. On the plus side, however, building the Olympic village provided a £6 billion boost to the building and construction industry.

But what happens to the people who originally lived on the site of the proposed new venues and athletes' village? Quite simply, they are moved on. While they may receive some compensation, land values go up in the shadow of renewed development. Residents simply cannot afford to live in the new developments, nor can they afford to renovate their existing dwelling. In the lead-up to the Beijing Olympics, 1.5 million Chinese people were forced out of their homes to make way for Olympics venues.

Once the event is over, many of the stadiums are under-used, and it can take years to recover from the cost of staging the event. The city of Montreal, for instance, took 30 years to pay back the equivalent of US$6 billion (in today's money) in Olympic spending.

eBook*plus*

Interactivity
Are the Olympics worth gold?
Use this interactivity to further your understanding of the economic impacts of the Olympic Games.
Searchlight ID: int-3337

17.5.3 What is the status of other sports events?

It has generally been accepted that regular sporting events can have financial benefits. In 2014, eight per cent of international tourists visiting the United Kingdom included a sporting event on their itinerary. Most popular was soccer, because of the opportunity to see some of the world's most talented athletes playing in some of the UK's top teams. Official figures show that these fans spent an average of £850 — far more than the average £570 spent by the rest of the tourist population.

Overall, sports tourists stay longer and are not deterred by the weather. Sports and recreation tourism is growing by 14 per cent annually compared with 5 per cent for the rest of the tourism sector.

FIGURE 3 The opening ceremony of the London Olympic Games



FIGURE 4 The Barmy Army comprises thousands of fans who come to Australia to cheer on the English cricket team.



But it is not just football that attracts the crowds. The English cricket team is followed around the world by its unofficial cheer squad, nicknamed the Barmy Army. Other 'fanatics' based in Australia organise 58 tours to 57 destinations each year, taking in some of the biggest sporting events both at home and abroad.

FOCUS ON FIELDWORK

Personal connections

Primary data collection — destination survey
Primary data is vital to a geographer when they are trying to collect and analyse information. Interviews, questionnaires and surveys provide an excellent source of primary data that is straightforward to collect and tailor-made for the task being carried out. Conduct some primary research by comparing popular potential tourist destinations along with the reasons for travel. You could survey your classmates or use your online connections. When your information has been collected, create a table to show the most popular destinations as well as the most common reasons for travel. What other ways do you think you could display your findings?

ACTIVITIES

IDENTIFY

1 **a** Is someone who goes to a local football match a tourist? Explain.
b What if that person travels interstate? Explain.

EXPLAIN

2 Brainstorm a list of sports that might spend money to attract tourists. Categorise these as **hard** and **soft sport tourism** events.
3 Compile a table that highlights the positives and negatives of sport tourism. Choose two positives and two negatives. For each, explain the impact it has on people and ***places***.

APPLY

4 The Phillip Island Grand Prix racing circuit is located 100 kilometres south of Melbourne, Victoria. The island is linked to the mainland by a bridge. The area is popular for its beaches and wildlife, but it is also home to a racing circuit. More than $110 million is generated annually from the circuit's car and bike activities with major events bringing more than 65 000 people to the island.
a What facilities would be needed to cater for such a large influx of people?
b Figure 3 in section 17.7 shows how the tourist dollar can flow from one job to the next. Complete a diagram like this for the Phillip Island Grand Prix circuit.
c Do you think this is an example of ***sustainable*** tourism? Justify your point of view.

hard sport tourism tourism in which someone travels to either actively participate in or watch a competitive sport as the main reason for their travel

soft sport tourism tourism in which someone participates in recreational and leisure activities, such as skiing, fishing and hiking, as an incidental part of their travel

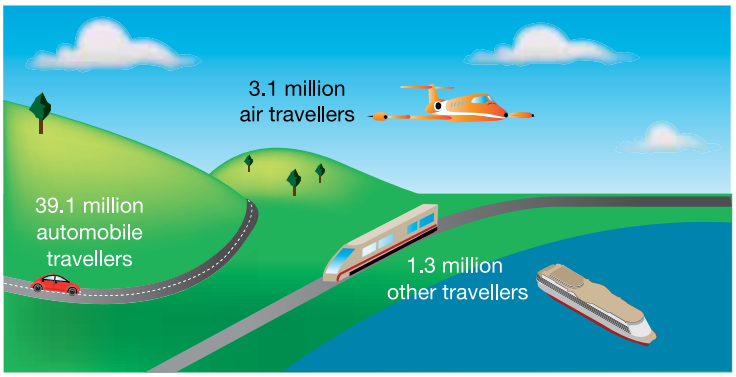
myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› Sport
› The FIFA World Cup

17.6 Cultural tourism?

17.6.1 What is the impact of Thanksgiving?

Cultural tourism is concerned with the way of life of people in a geographical region. It is usually connected to elements that have shaped their values or culture, such as a shared history, traditions or religion. It may be linked to unique events, such as the celebration of Chinese New Year or Thanksgiving in the United States. Whatever the reason, the mass movement of people associated with these events has a significant impact on both people and places.

FIGURE 1 Thanksgiving and modes of transport



Thanksgiving is held in the United States on the fourth Thursday in November. It dates back to the seventeenth-century celebration of the harvest. Today it is a time for families to get together and give thanks for what they have.

The holiday period runs from Wednesday to Sunday. In 2014, around 46.3 million people travelled an average of 883.5 kilometres to celebrate with family and friends (see figure 1). As millions of people travel across the country, transport systems are stretched to the limits, creating delays and traffic congestion. Because the holiday season is so close to the start of winter, the weather can further complicate people's travel plans, especially those who live in the northern states. Early winter storms can bring ice and snow, resulting in airport closures and impassable roads.

Surprisingly, in 2012, the cost of travel decreased around the time of Thanksgiving. Travellers paid less for fuel, car hire, accommodation and airfares. However, economic conditions in the United States have meant that the average American spent less.

new moon the phase of the moon when it is closest to the sun and is not normally visible

winter solstice the shortest day of the year, when the sun reaches its lowest point in relation to the equator

17.6.2 What is the impact of Chinese New Year?

Chinese New Year is the longest and most important of traditional Chinese holidays. Dating back centuries, it is steeped in ancient myths and traditions. The festivities begin on the first day of the first month in the traditional Chinese calendar, and last for 15 days. They conclude with the lantern festival on Chinese New Year's Eve, a day when families gather for their annual reunion dinner. It is considered a major holiday, and it influences not only China's geographical neighbours but also the nations with whom China has economic ties.

Of special significance is the fact that the date on which Chinese New Year occurs varies from year to year. This date coincides with the second **new moon** after the Chinese **winter solstice**, which can occur any time between 21 January and 20 February.

Chinese New Year, or Lunar New Year, is celebrated as a public holiday in many countries with large Chinese populations or with calendars based on the Chinese lunar calendar (see figure 2). The changing nature of this holiday has meant that many governments have to shift working days to accommodate this event.

FIGURE 2 To ensure prosperity and good fortune in the year ahead, parades, dragons and lion dances feature in Chinese New Year celebrations.



FIGURE 3 The long way home for Chinese New Year



Source: Spatial Vision

In China itself, many manufacturing centres close down for the 15-day period, allowing tens of millions of people to travel from the industrial cities where they work to their hometowns and rural communities. This means that retailers and manufacturers in overseas countries such as the United States and Australia have to adjust their production and shipping schedules to ensure they have enough stock on hand to deal with the closure of factories in China. For those shopping online, goods simply will not be available and will be placed on back order.

The logistics of movement in China

Chinese New Year has been described as the world's biggest annual movement of people. In China, over a five-day period in 2014, 92 500 buses moved 82 million people per day; 14 700 extra flights and 800 additional train services were scheduled. The Ministry of Transport has introduced online ticketing, but the website crashed and now there are problems with scalpers. Some would-be commuters tried for hours to log on, while others queued for up to six days only to find there were no more tickets. One airline traveller flew from Beijing to Kunming in southern China via Bangkok because he could not get a direct flight (see figure 3). Road networks were monitored from the air as tens of thousands made the journey on motorcycles.

eBook*plus*

Weblink
Thanksgiving

ACTIVITIES

EXPLAIN

1 In your own words, explain what is meant by the term *cultural tourism*.
2 Why are Thanksgiving and Chinese New Year regarded as cultural events?

INVESTIGATE

3 As a class, brainstorm a list of cultural or celebratory events that occur in Australia.
4 Use the internet to find out more about either Chinese New Year or Thanksgiving. Investigate the history, myths and traditions associated with your chosen event. Prepare an annotated visual display comparing your finding with a cultural or celebratory event in Australia. Make sure you include references to the *scale* of your chosen event and the *place* in which it occurs.

APPLY

5 Copy the table below into your workbook and fill it in. Use the **Thanksgiving** weblink in your eBookPLUS to find out more and help you complete your table.
   a What is the preferred mode of transport for Thanksgiving and for Chinese New Year? Suggest reasons for differences in travel arrangements. In your response, include reference to the ***scale*** of movement.
   b Make a list of problems associated with the mass movement of people.
   c Select one of the problems you have identified and explain the impact it might have on people, ***places*** and the ***environment***. Suggest a strategy for the ***sustainable*** management of this problem in order to reduce its impact.
6 Write a paragraph explaining how cultural events can ***change*** people, ***places*** and the ***environment***.

	Thanksgiving	Chinese New Year
Number of trips		
Most common form of transport		
Length of holiday period		
Purpose of trip/activities		

17.7 Impacts of travel

17.7.1 Do the benefits outweigh the costs?

Travelling, and more specifically tourism, seems like the perfect industry. It can encourage greater understanding between people and bring prosperity to communities (see figure 2). However, tourism development can also destroy people's culture and the places in which they live (see figure 1). There is sometimes a fine line between exploitation and sustainable tourism.

Many travellers don't consider or are unaware of the consequences their choices have on both the environment and people of the destination they are visiting. Conversely, many tourists leave their holiday destinations feeling uplifted by their positive experiences and seek to return the favour. The following mind maps outline just some of the impacts that tourism has on people and places.

eBook*plus*

Interactivity
Tourism trauma
Use this interactivity to further your understanding of the effects of tourism.
Searchlight ID: int-3335

FIGURE 1 The negative impacts of tourism

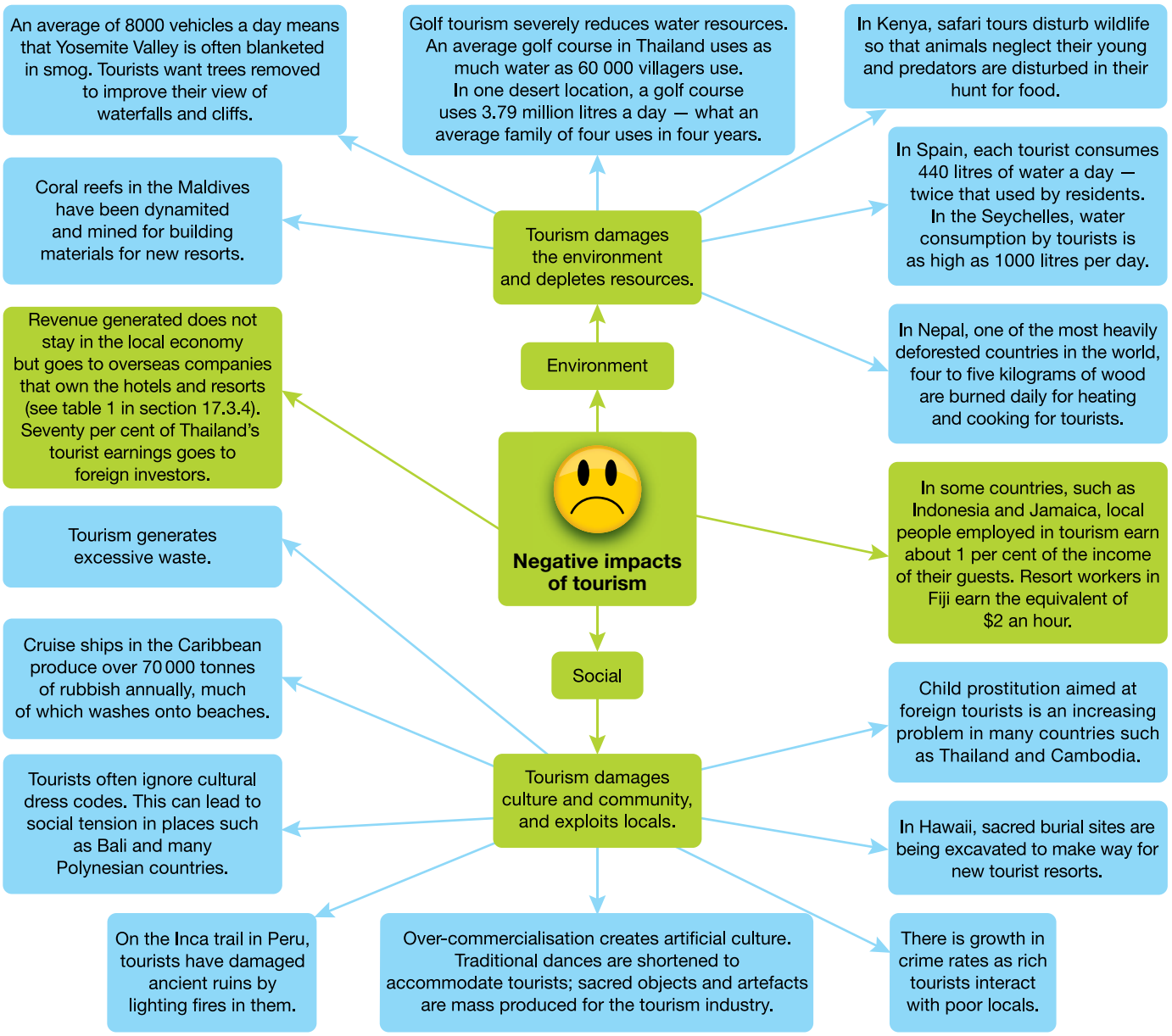
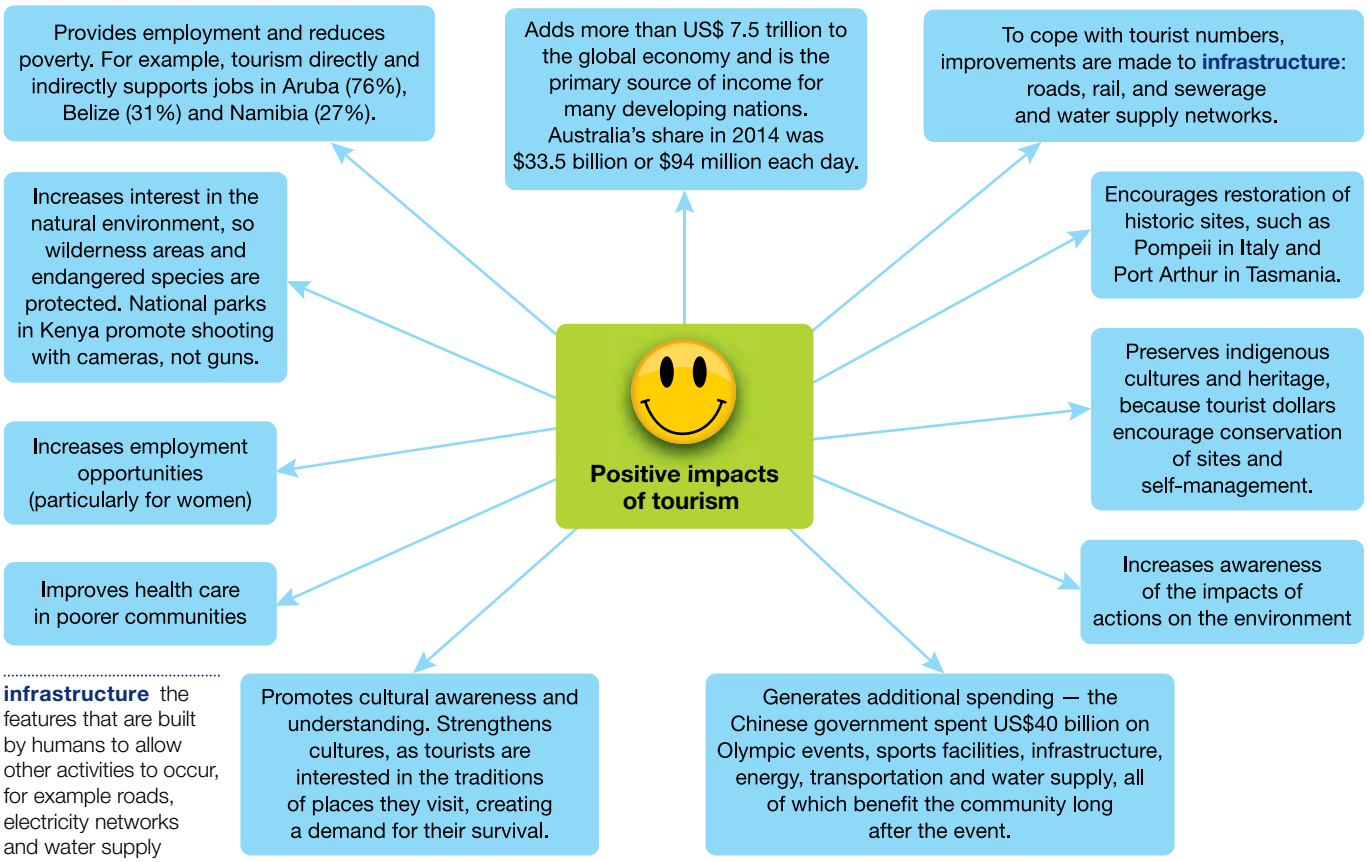


FIGURE 2 The positive impacts of tourism



infrastructure the features that are built by humans to allow other activities to occur, for example roads, electricity networks and water supply

GEOskills TOOLBOX

Flow diagrams

A flow diagram can illustrate how an idea or thing can link to another and then another. It is a good way of showing how certain examples can be connected back to an original concept.

ACTIVITIES

EXPLAIN

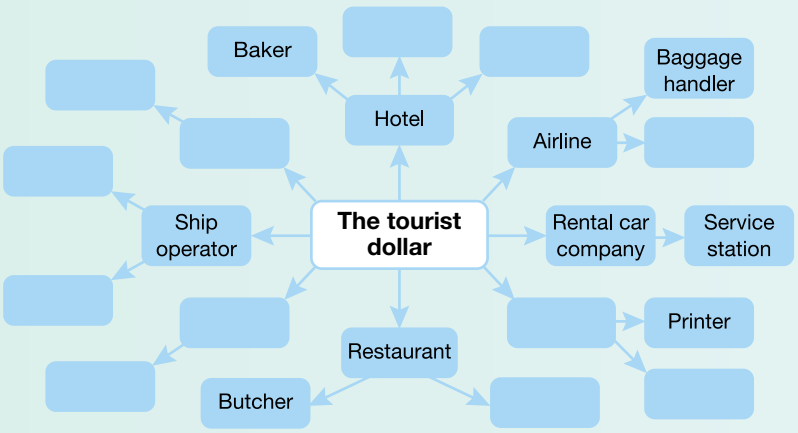
1 Using figures 1 and 2, explain how tourism can have both positive and negative effects.

2 **a** Figure 3 shows how the tourist dollar can flow from one job to the next. Those jobs in the centre of the diagram interact directly with the tourist, while those on the outside do not. Copy the diagram into your workbook at an enlarged size. Complete it by adding other jobs. Add to it if you can. Study your completed diagram and write a paragraph explaining the ***interconnection*** between tourism and the economy.

b Repeat this exercise looking at either the social or ***environmental*** impacts.

3 The type of ***interconnection*** shown between industries in figure 3 is sometimes called the multiplier effect. Explain what you think this means.

FIGURE 3 One view on tourism



4 The impact of tourism can be classified as ***environmental***, cultural and economic. Study figure 1, showing the negative impacts of tourism. Working in groups of three, select an impact from each group. Explain the ***scale*** of each impact and devise a strategy for ***sustainable*** tourism.

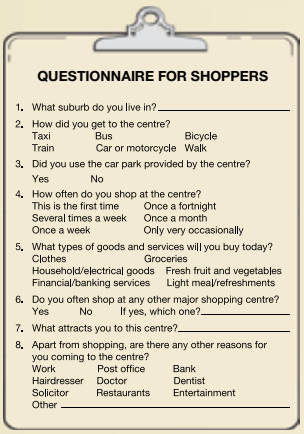
5 Which of the following would be the best to develop as a tourist resource in your region: art gallery, museum, cinema complex or sports stadium? Justify your answer.

eBook*plus* ONLINE ONLY

17.8 SkillBuilder: Creating a survey

What is a survey?

Surveys collect primary data. A survey involves asking questions, recording and collecting responses, and collating and interpreting the number of responses. Surveys are useful because they provide statistics for a specific topic that might not be available by any other means.



QUESTIONNAIRE FOR SHOPPERS

1. What suburb do you live in?_____
2. How did you get to the centre?
   Taxi Bus Bicycle
   Train Car or motorcycle Walk
3. Did you use the car park provided by the centre?
   Yes No
4. How often do you shop at the centre?
   This is the first time Once a fortnight
   Several times a week Once a month
   Once a week Only very occasionally
5. What types of goods and services will you buy today?
   Clothes Groceries
   Household/electrical goods Fresh fruit and vegetables
   Financial/banking services Light meal/refreshments
6. Do you often shop at any other major shopping centre?
   Yes No If yes, which one?_____
7. What attracts you to this centre?_____
8. Apart from shopping, are there any other reasons for you coming to the centre?
   Work Post office Bank
   Hairdresser Doctor Dentist
   Solicitor Restaurants Entertainment
   Other _____

eLesson

Watch this video to learn how to create a survey.



Searchlight ID: eles-1764

Interactivity

Try this interactivity to learn how to create a survey.



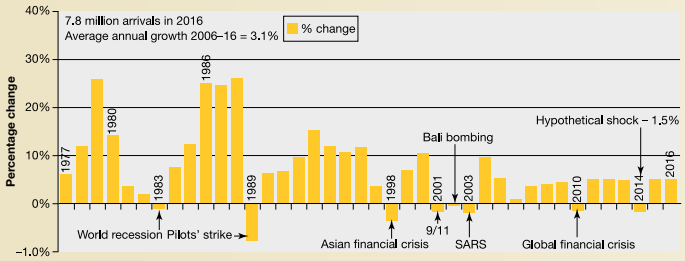
Searchlight ID: int-3382

eBook*plus* ONLINE ONLY

17.9 SkillBuilder: Describing divergence graphs

What is a divergence graph?

A divergence graph is a graph that is drawn above and below a zero line. Those numbers above the line are positive, showing the amount above zero. Negative numbers that are shown indicate that the data has fallen below zero. A divergence graph allows you to identify changes away from the normal in a trend.



eLesson

Watch this video to learn how to describe a divergence graph.



Searchlight ID: eles-1739

Interactivity

Try this interactivity to learn how to describe a divergence graph



Searchlight ID: int-3357

17.10 Future trends and sustainability

FIGURE 1 Scientist Dr Stephen Hawking was one of many famous clients to experience weightless flights.



17.10.1 Space tourism

One hundred years ago most travel was undertaken for the purposes of work, migration or war. Only the very wealthy were able to travel for leisure. Since the 1950s we have seen an increase to global tourism of 4400 per cent. Today tourism and travel is a **mass market** product. The growth of package holiday and 'bucket and spade' culture during the past half century along with the growth of low-cost airlines has seen tourism shift from being just about two weeks of sun and fun to ticking items off people's **bucket list**.

Travel to space is an emerging industry. In 2004 the first non-government organisation launched a manned craft into space twice in two weeks. Since then we have had individual tourists stay on the international space station whilst people are already booking to stay in hotels on the moon.

mass market the market for goods that are produced in large quantities

bucket list a list of things a person wants to do before they die or 'kick the bucket'

Zero Gravity Corporation celebrates 10 years of weightless flights

A company that makes some of the thrills of spaceflight more accessible to regular folks has hit a major milestone — 10 years of weightless flights.

The Virginia-based Zero Gravity Corp. (Zero G) has now been flying customers on a specially modified Boeing 727 jet for a decade. The plane, known as G-Force One, flies in parabolic arcs that generate brief periods of weightlessness.

Customers usually pay $4 950 for this experience, which can be exhilarating and nauseating at the same time. (G-Force One is sometimes referred to as a "vomit comet.") But the company is knocking 20 percent off the price for all future flights this year.

"We've flown over 500 weightless flights with more than 12,000 clients, including notables like Stephen Hawking, James Cameron, Kate Upton, Halle Berry, Martha Stewart, Sharon & Ozzy Osbourne and Rob Dyrdek. It's been amazing!" Terese Brewster, ZERO-G president and chief operating officer, said in a statement. "In celebration of our 10-year anniversary, we want to say 'thank you' by discounting all remaining 2015 seats."

Source: Mike Davis 25/09/2015 Space.com

17.10.2 The sustainability dilemma

People recognise the benefits that responsible and sustainable tourism can bring to destinations, in terms of employment and the preservation of cultural and natural heritage. However, we are also aware of the growing contribution that flying makes to global warming. Currently aviation accounts for 2 per cent of all CO^2 emissions and 12 per cent of CO^2 from the transport industry. How can we align a desire to visit other cultures in a thoughtful way alongside a conscience that calls for the reduction in our everyday carbon emissions?

17.10.3 What's next?

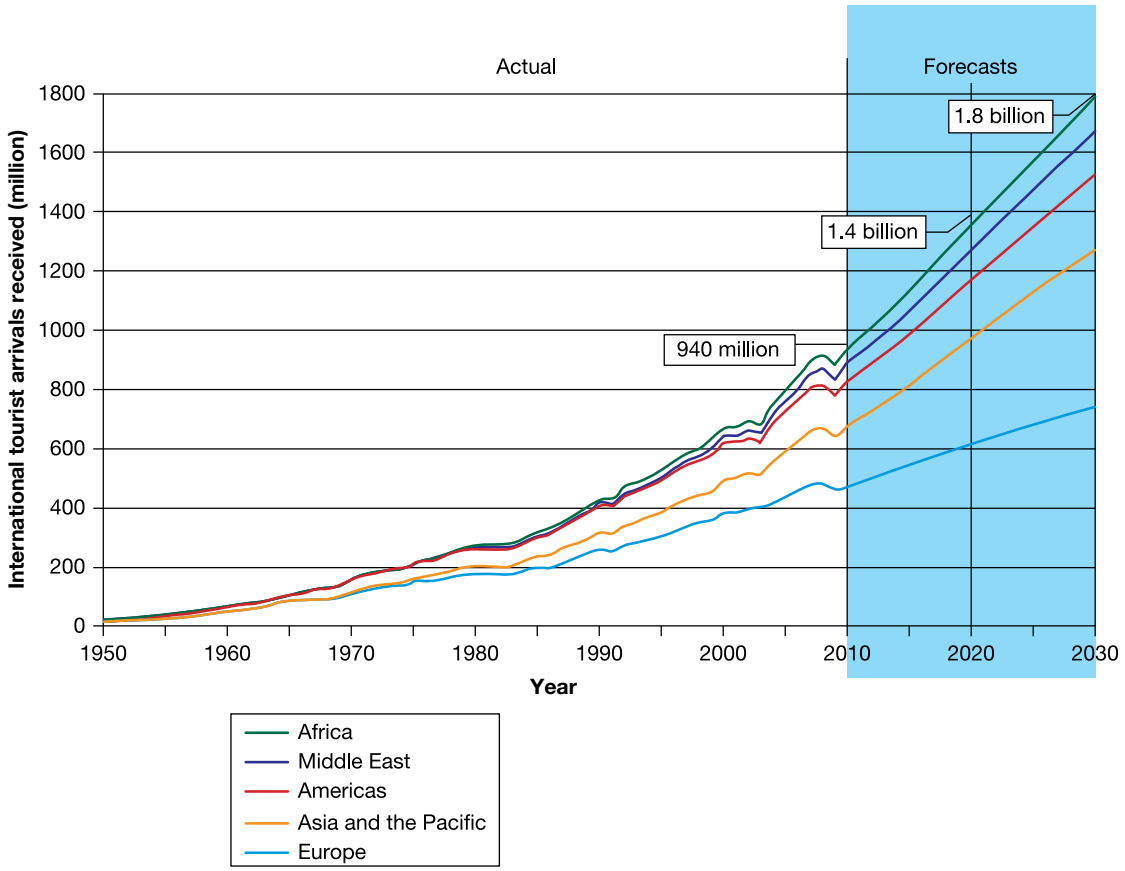
As the cost of flying increases, the 'local' approach to travelling will become more appealing. A new term has emerged in the travel industry of 'geo-local'. In other words, holidaymakers will travel less far from home. We'll begin to travel more often within our own countries and continents, and less frequently

beyond them. Australians may begin to travel more to bush homesteads in rural settings, sleeping 'under the stars' and eat bush tucker. Holidaymakers will increasingly discover that the exoticness of the unknown doesn't have to take the form of a safari through the Africa Savanna.

Tourism will no longer be dominated by Westerners either. We'll see residents of India and China becoming more mobile than ever before, from a leisure perspective. Already, hotels in India and China, that once hosted Western visitors almost exclusively, are beginning to see the proportion of domestic guests rise, in some cases overtaking the number of foreign guests.

By 2020, we'll also see the majority of hotels getting their produce, employees, materials, services and the like from sources within their immediate vicinity. We may see a new type of '10-kilometre hotel' — for which all food and materials will have been sourced from within a 10-kilometre radius. In addition, these hotels can provide energy and water for guests on a metered system, and separate charges for each will appear on their bill. Discounts will be offered for those visitors who keep their energy and water use below average.

FIGURE 2 Trends and forecasts in tourist arrivals



ACTIVITIES

IDENTIFY

1 What are the reasons for the increase in tourism since the 1950s?

2 Read the article entitled 'Zero Gravity Corporation celebrates 10 years of weightless flights'.
- **a** Why would families like the Stern family choose to go on a Zero G holiday?
- **b** What modifications do you think would need to be made to the aircraft and why?

INVESTIGATE

3 Find a company that offers space flight holidays. What are the costs and physical requirements for potential passengers?

4 Design a centre for space tourists. What would be the major obstacles to overcome in the construction of the centre?

APPLY

5 **a** Refer to figure 2. Which region is projected to have the greatest increase in tourist arrivals between 2010 and 2030?
- **b** What is the total and relative increase in tourism numbers between 2010 and 2030?
- **c** List the advantages of a geo-local holiday.
- **d** Plan your own geo-local holiday — where would you like to go and why?
- **e** What are the implications for the tourism industry for the changing nature of where tourists are coming from?

17.11 Sustainability and ecotourism

ecotourism tourism that interprets the natural and cultural environment for visitors, and manages the environment in a way that is ecologically sustainable

17.11.1 Ecotourism and the environment

Tourism has the capacity to benefit environments and cultures or destroy them. **Ecotourism** has developed in response to this issue. The aim is to manage tourism in a sustainable way. This might be through educational programs related to the environment or cultural heritage, or through controlling the type and location of tourist activities or the number of tourists visiting an area.

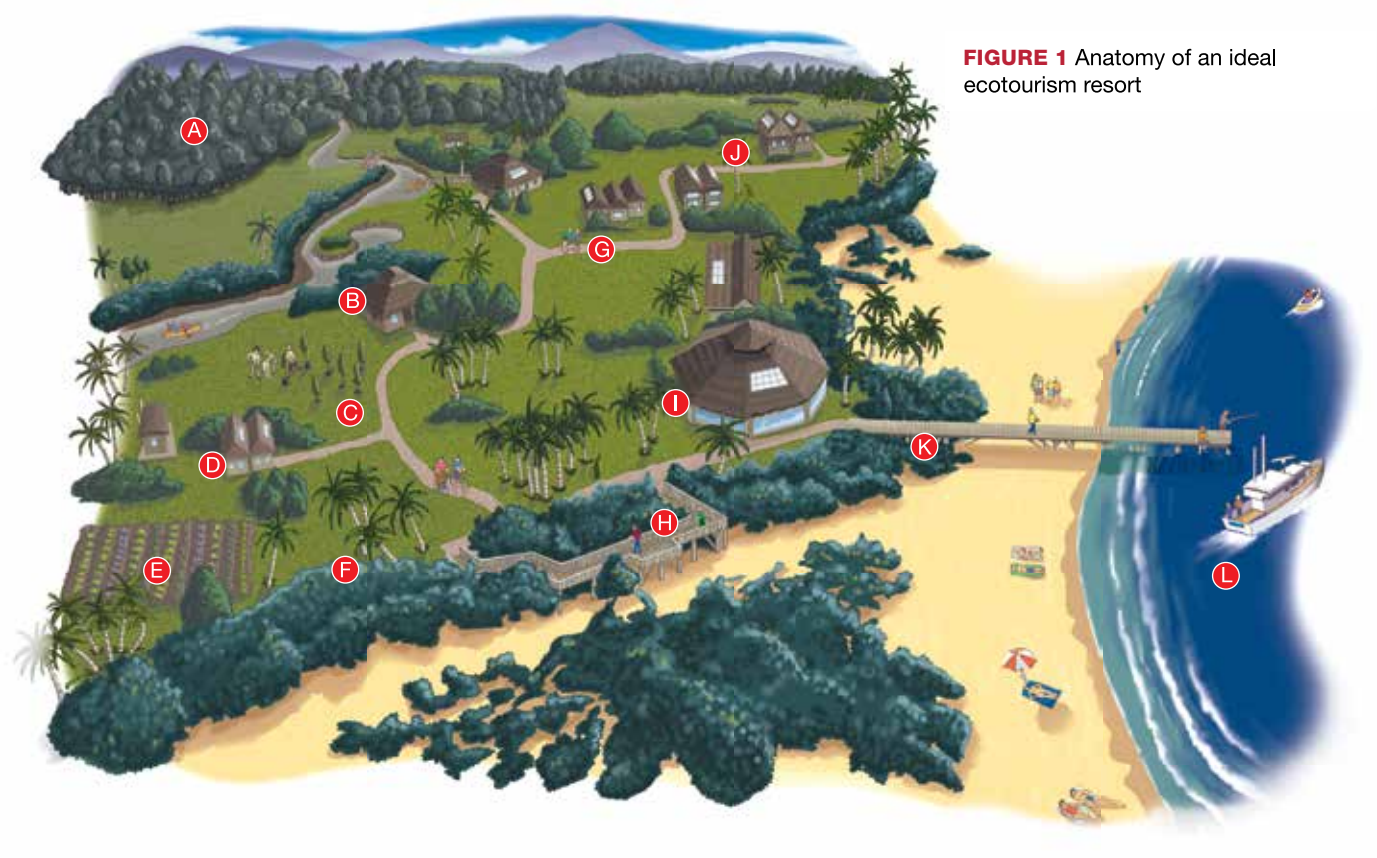
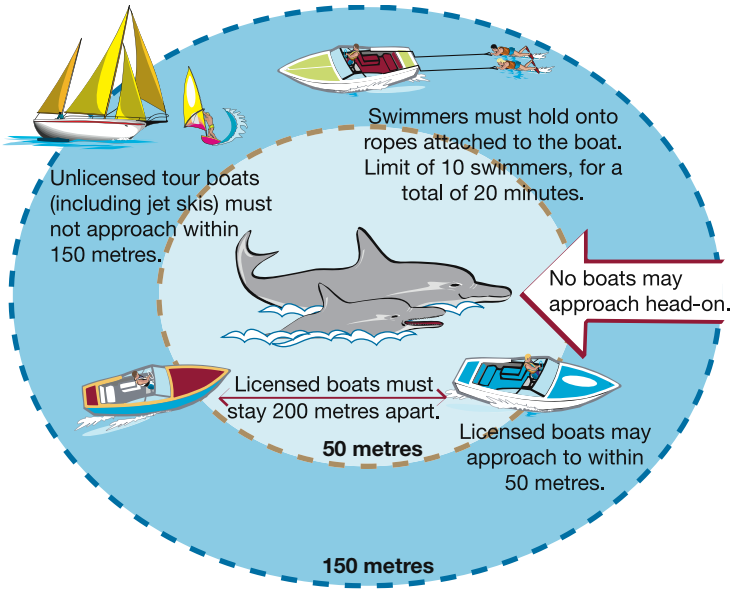


FIGURE 1 Anatomy of an ideal ecotourism resort

- **A** The natural bush is retained and native plants are used to revegetate or landscape the area.
- **B** Composting toilets treat human waste, and worm farms consume food waste. Water is treated with ultraviolet light rather than chlorine. Recycling is practised; for example, grey water is used in irrigation and toilet systems.
- **C** Visitors are encouraged to improve and maintain the environment by using paths or planting trees.
- **D** Buildings blend in with the natural landscape, and local materials are used. Buildings are often raised to prevent damage to plant roots. During construction, builders prevent contamination of the local environment by having workers change shoes and by washing down equipment to keep out foreign organisms.
- **E** Local organically grown produce is used, and craft markets and stalls might also be established and run by indigenous communities, supporting the local economy, creating jobs and reducing poverty.
- **F** There is no golf course, because of the high water use and need for pesticides it would require.
- **G** Low-impact, non-polluting transport such as bicycles are provided for guests.
- **H** Walking trails include educational information boards.
- **I** An information centre helps visitors understand the environment. Local indigenous people are employed to educate visitors about their culture.
- **J** Electricity is generated through solar panels on the roofs of eco-cabins.
- **K** Boardwalks are built over sensitive areas such as sand dunes to protect them from damage. Boardwalks might also be constructed in the tree canopies.
- **L** Trained guides educate tourists about coral reefs and native vegetation, and show visitors how to minimise their impact.

FIGURE 2 Regulations for contact with dolphins



Ecotourism differs from traditional tourism in two main ways.

- It recognises that many tourists wish to learn about the natural environment (such as reefs, rainforests and deserts) and the cultural environment (such as indigenous communities).
- It aims to limit the impact of tourist facilities and visitors on the environment.

Ecotourism is the fastest growing sector in the tourism industry, increasing at around 10 to 15 per cent per year.

Ecotourism Australia (EA) is an organisation that aims to promote ecotourism throughout Australia and the region. It was established in 1991 and has been a world leader and winner of many awards for its work in the field. The organisation aims to establish best practice in the tourism industry and provide information and certification for businesses that share the values of sustainability. In 2014, the value of tour operators certified by EA exceeded $1 billion. This proves the importance of ecotourism and that it is not just a niche segment of the industry.

ACTIVITIES

IDENTIFY

1 How does an ecotourism resort differ from a traditional tourist resort?

EXPLAIN

2 Use a mind map to explore further ***changes*** that could be made to the resort shown in figure 1 to make it even more ***environmentally*** friendly. Would you describe your ***changes*** as small-***scale*** or large-***scale***? Justify how these ***changes*** might be more ***environmentally sustainable***.

INVESTIGATE

3 Visitors to ecotourism resorts are often attracted by brochures that emphasise the resort's ***environmental*** policies. These brochures also set out guidelines to follow in order to minimise visitor impact.

- **a** Design and produce a brochure for the ecotourism resort illustrated in figure 1. Use ICT tools and techniques to maximise the brochure's impact.
- **b** Add another eco-activity to the island and devise strategies to educate tourists and minimise their impact on the ***environment***.

APPLY

4 One of the most famous examples of wildlife-based ecotourism in Australia is Monkey Mia in Western Australia. Here the wild dolphins come into shore and tourists are able to feed them.

- **a** What rules and other techniques are used to control the interaction between dolphins and tourists?
- **b** Predict potential problems that might occur between dolphins and tourists.
- **c** Do you think this is an example of ***sustainable*** ecotourism? Give reasons for your answer.

eBook*plus*

Interactivity
Sustainable sightseeing
Use this interactivity to further your understanding of how ecotourism differs from traditional tourism.
Searchlight ID: int-3336

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
- **Kakadu National Park**
- **Wilsons Promontory**
- **Ningaloo Reef and ecotourism**

17.12 How does nature drive tourism at Victoria Falls?

17.12.1 Tourist mecca

Victoria Falls, or Mosi-oa-Tunya, has been recognised as a World Heritage site due to its spectacular waterfalls. The Falls attract several hundred thousand visitors from around the world each year, which has led to the development of numerous tourist businesses to cater to them.

FIGURE 1 Oblique aerial photo of Victoria Falls



UNESCO has deemed Victoria Falls to be a site of exceptional natural beauty and of geological importance. The main falls, located on the Zimbabwe side of the border with Zambia, drop in excess of 100 metres. Due to the outstanding universal value posed by this collection of waterfalls, a significant tourism industry has sprung up on both sides of the border. Victoria Falls cover an area of 6860 hectares. The region is used for a variety of tourist activities including rafting, helicopter flights, walking with lions, abseiling and bungee jumping, bush walks, mountain biking, jet boats, horseback and elephant back safaris, as well as fly fishing.

ACTIVITIES

IDENTIFY

1. Describe the main vegetation types on the map.
2. What physical feature forms a natural boundary between Zambia and Zimbabwe?
   - a A gorge
   - b A perennial lake
   - c A dam
3. What physical feature can be found at AR7415?
4. Give the area reference for Canary Island.
5. What is the contour interval of the map?
6. In what direction is Main Falls from Lwando Island?
7. What is found at GR757183?
8. Calculate the distance by road from the boat club to Big Tree.
9. How do people staying in Livingstone, Zambia, get to Victoria Falls?
10. Refer to figure 1.
    - a In what direction would the photographer have been facing when they took the photo?
    - b What natural features would attract visitors to Victoria Falls?

INVESTIGATE

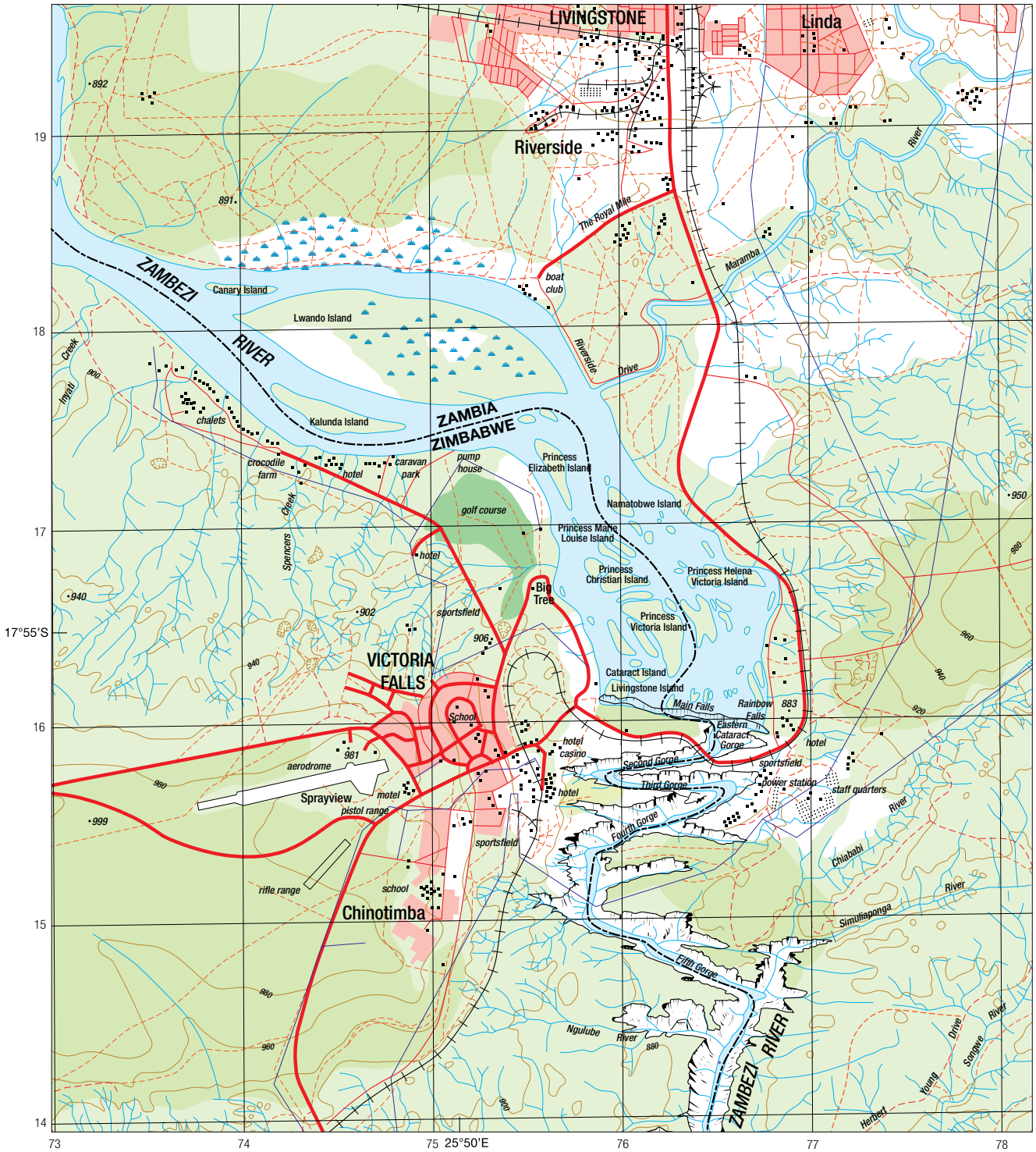
11. List as many human features on the map as you can that have been built because Victoria Falls is a tourist destination.
12. What would be some of the main impacts of the tourist facilities, established in and around Victoria Falls, on the ***environment*** and on people who live in this region?
13. Evaluate the impacts (positive and negative) of tourism to this area.
14. How might Victoria Falls allow for the ***interconnection*** of people from different cultures?

eBook*plus* ONLINE ONLY

17.13 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

FIGURE 2 Topographic map extract of Victoria Falls, Zambia and Zimbabwe



SCALE 1 : 50 000

kilometres 0 1 2 3 kilometres

N
W E
S

sealed unsealed

- Principal road; Built-up area
- Secondary road
- Track; Building/s
- Single track railway
- Powerline
- International boundary

- Quarry; Contour with value (interval 20 metres)
- Golf course; Spot height (metres)
- Sparse bush; Dense bush
- Watercourse; Waterfall; Marsh
- Gorge; Perennial lake; Dam

Source: Spatial Vision

17.4 SkillBuilder: Constructing and describing a doughnut chart

17.4.1 Tell me

What is a doughnut chart?

A doughnut chart is a circular chart with a hole in the middle. Each part of the doughnut is divided as if it were a pie chart with a cut-out. The circle represents the total, or 100 per cent, of whatever is being looked at. The size of the segments is easily seen. Presenting the parts in order from largest to smallest makes it easy to interpret.

Why is a doughnut chart useful?

Doughnut charts are a useful visual interpretation of data. Just like a pie chart, they give us an overall impression of data. They are useful for comparing proportions of categories. You will find them easy to read, as they show a lot of data and make it easy for us to interpret and compare this data. You can use these in class to graph any data that adds up to 100 per cent.
They are also useful for:

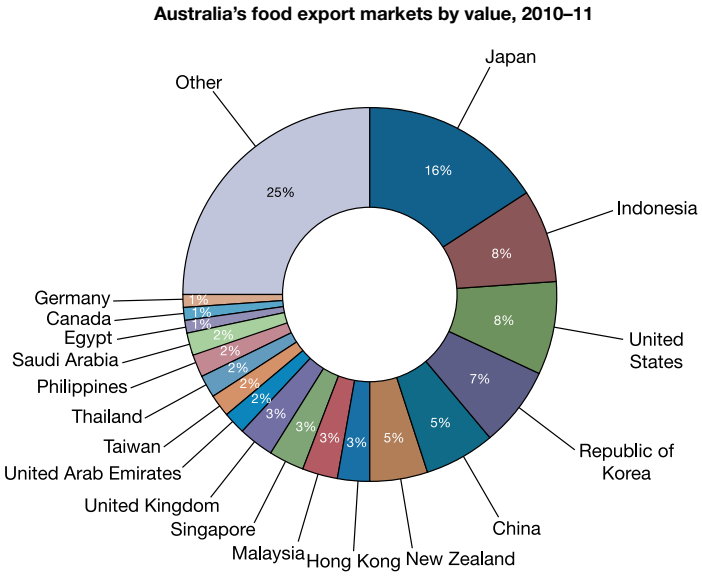
- economists showing segments of a country's tourism industry
- agriculturalists showing the percentage of various crops on the land
- retailers comparing the importance of various goods in their stores during different years.

Model

TABLE 1 Australia's food export markets by value, 2010–11

Country	Value ($ million)
Japan	4207
Indonesia	2288
United States	2138
Korea, Rep. of	1994
China	1511
New Zealand	1281
Hong Kong, China	886
Malaysia	849
Singapore	739
United Kingdom	692
United Arab Emirates	581
Taiwan	569
Thailand	539
Philippines	502
Saudi Arabia	499
Egypt	402
Canada	332
Germany	263
Other	6815

FIGURE 1 Doughnut chart showing Australia's food export markets by value, 2010–11



Source: © DAFF 2012, National Food Plan green paper 2012, Department of Agriculture, Fisheries and Forestry, Canberra. CC BY 3.0.

Australia's food exports go to a large number of countries. These countries are predominantly in Asia, with the exception of the United States and New Zealand. Japan is Australia's greatest importer of food by monetary value, with $4207 million of imports in 2010–11, or about 16 per cent. Indonesia, the Republic of Korea and China are the other significant Asian buyers of Australian food. Asian countries account for 51 per cent of all our food exports, while the United States and New Zealand account for 13 per cent of Australia's food exports. Europe and the Middle East take less of our food.

A good doughnut chart:

- has a hole at its centre
- has segments that are labelled with names, or has a key
- includes percentages and/or raw figures
- is drawn with the largest segment starting at 12 o'clock, proceeding clockwise from largest to smallest, unless there is an 'other' category, which comes last
- gives the source of the data
- has a clear title.

A good description of a doughnut chart:

- identifies and communicates key features, such as highest and lowest data values
- refers to data and names.

eBook*plus*

eLesson
Constructing and describing a doughnut chart
Searchlight ID: eles-1738

17.4.2 Show me

How to construct and describe a doughnut chart

You will need:

- a set of data
- a computer
- a blank Excel spreadsheet.

Procedure:

STEP 1

Open a spreadsheet in Excel. Into the spreadsheet, add the data that you wish to graph. If the data is in the form of whole numbers, you will need to convert them to percentages. If the total of the whole numbers is not given, you will have to add the numbers together to get the total. Excel will do this for you with the Auto Sum function (Σ) in the toolbar. For example, using the data that went into figure 1, select all the data in column B plus row 20 (see figure 2a). Then click on the Auto Sum symbol and the total will appear in cell B20 (figure 2b).

FIGURE 2 (a) Selecting the column. (b) The total appears when you click the Σ button in the Editing section of the toolbar.

(a)	A	B
1	Japan	4207
2	Indonesia	2288
3	United States	2138
4	Republic of Korea	1994
5	China	1511
6	New Zealand	1281
7	Hong Kong	886
8	Malaysia	849
9	Singapore	739
10	United Kingdom	692
11	United Arab Emirates	581
12	Taiwan	569
13	Thailand	539
14	Philippines	502
15	Saudi Arabia	499
16	Egypt	402
17	Canada	332
18	Germany	263
19	Other	6815

(b)	B
	4207
	2288
	2138
	1994
	1511
	1281
	886
	849
	739
	692
	581
	569
	539
	502
	499
	402
	332
	263
	6815

STEP 2

To complete the percentage column, click on the first cell of a new column, cell C1, and type in the formula =B1/B20. (The $ sign is used to make sure that one specific cell is referred to. Make sure the final number, 20 in this example, is the cell number in which the total appears. This will change with each set of data you enter.) Press Enter and a decimal number will appear. Now click the percentage symbol (%) in the Number section of the toolbar, and the figure in cell C1 will appear as a percentage.

STEP 3

Click on cell C1, and you will see a small black square in the bottom right corner (see figure 3a). Using the cursor, drag this down over the remaining rows to be calculated. Do not include the row in which the total is shown (row 20 in this example). The percentages for all remaining cells will appear. Figure 3b shows a completed chart.

FIGURE 3 (a) Use the cursor to drag the bottom right corner of a cell over the remaining rows to be calculated. (b) Percentage data is now complete.

(a)

	A	B	C
1	Japan	4207	16%
2	Indonesia	2288	
3	United States	2138	

Small black square

(b)

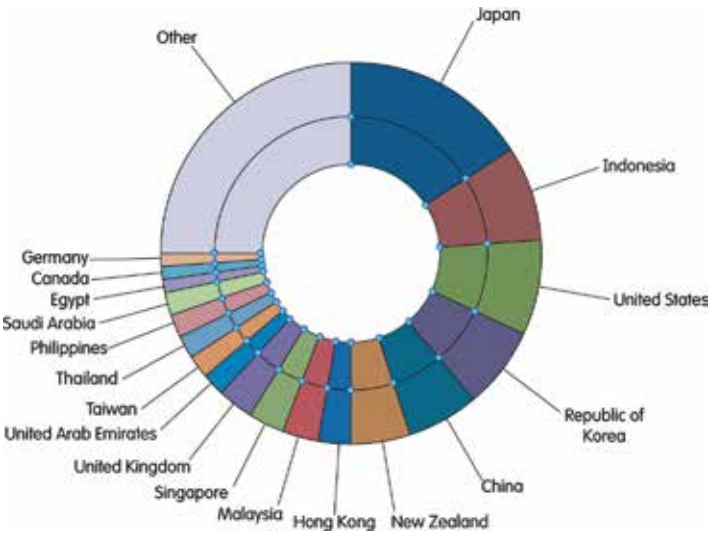
	A	B	C
1	Japan	4207	16%
2	Indonesia	2288	8%
3	United States	2138	8%
4	Republic of Korea	1994	7%
5	China	1511	6%
6	New Zealand	1281	5%
7	Hong Kong	886	3%
8	Malaysia	849	3%
9	Singapore	739	3%
10	United Kingdom	692	3%
11	United Arab Emirates	581	2%
12	Taiwan	569	2%
13	Thailand	539	2%
14	Philippines	502	2%
15	Saudi Arabia	499	2%
16	Egypt	402	1%
17	Canada	332	1%
18	Germany	263	1%
19	Other	6815	25%
20		**27087**	

STEP 4

You can now generate the doughnut chart. To do this, select all columns and rows in which your data appears, excluding the total figure (columns A, B and C and rows 1 to 19 in this example), and then click the Insert tab on your toolbar. In the Charts section, select Other Charts and choose the simple doughnut chart. The Excel spreadsheet will create a doughnut chart (see figure 4).

If your doughnut chart appears with a second, inner doughnut, click on this and delete it (see figure 4).

FIGURE 4 A completed doughnut chart. This one has a secondary ring within it, which needs to be deleted in this instance.



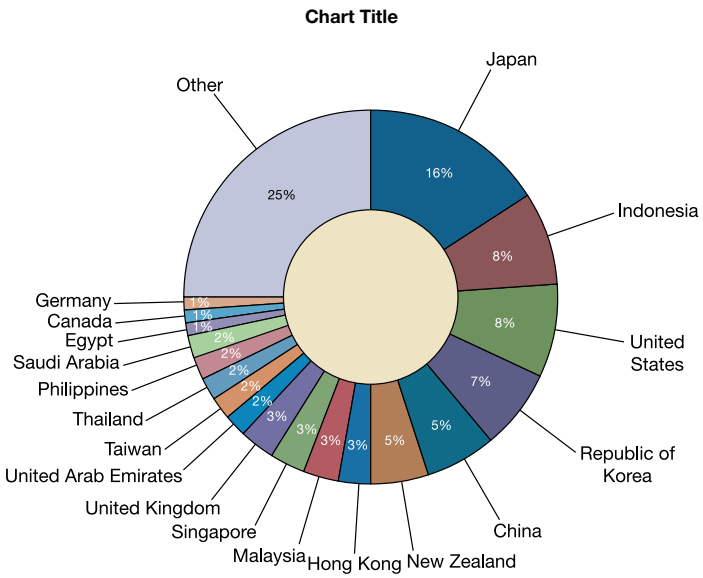
STEP 5

To make the percentage labels appear within your doughnut chart, click on the doughnut and select Chart Layouts in the Design tab on the toolbar, then choose a layout in which the percentage symbol (%) appears. Percentages will appear (see figure 5). Try different chart layouts to see which works best.

You might find that the chart appears small and cramped. If so, click on the outer rectangular border around your doughnut chart and drag it. As you do this, the chart will enlarge and the labels and legend will become easier to read.

You can also decrease the type size of the labels by clicking on one (which will highlight all of them), going to the Home tab and reducing the font size. You can do the same for the legend if necessary.

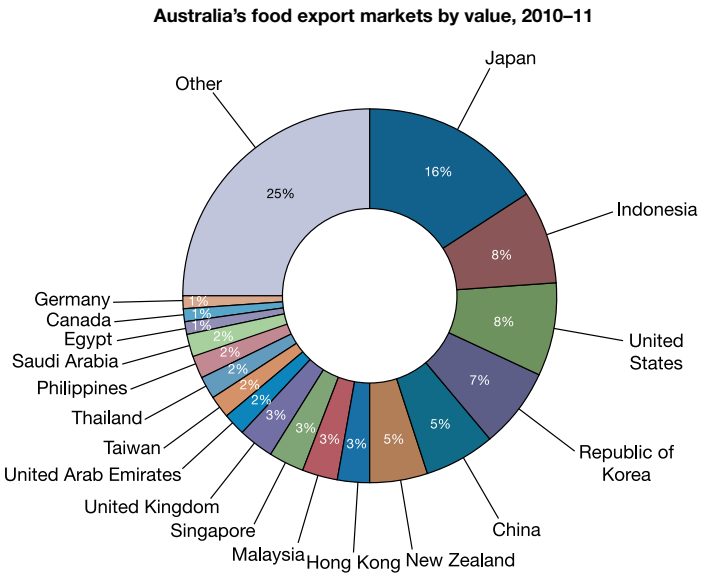
FIGURE 5 A doughnut chart with percentages added



STEP 6

You now need to add the title. Simply click on the heading *Chart Title* (see figure 5), type your title and then press Enter. Your title should include the places and dates for which this data was relevant. You should also provide the source of the data (see figure 6).

FIGURE 6 A doughnut chart with its legend and title in place, along with a source line



Source: © DAFF 2012, National Food Plan green paper 2012, Department of Agriculture, Fisheries and Forestry, Canberra. CC BY 3.0.

eBook*plus*

Interactivity
Constructing and describing a doughnut chart
Searchlight ID: int-3356

Developing my skills

Using the data in table 2, construct a doughnut chart and then write a description of the information it conveys.

TABLE 2 Origins of Australian tourists visiting Sydney, June 2012

Origin	Percentage
New South Wales	51.4
Victoria	20.2
Queensland	12.7
Australian Capital Territory	6.4
Other states	9.3

Questions

1. Where do most visitors to Sydney come from?
2. Suggest which states provide the fewest visitors to Sydney.
3. The ACT is within the boundaries of New South Wales but provides only 6.4 per cent of visitors. Can you explain why?
4. List two factors that might indicate why there is no separate category for visitors from South Australia.
5. What did your doughnut chart make clear, which the table did not?

Checklist

In drawing a doughnut chart I have:

- drawn a hole at the centre of the chart
- drawn segments that are labelled with names or have a key
- included percentages or raw figures
- drawn the largest segment starting at 12 o'clock, proceeding clockwise from largest to smallest, unless there is an 'other' category, which comes last
- provided the source of the data
- given my chart a clear title.

In writing a description of a doughnut chart I have:

- identified and communicated key features, such as the highest and lowest data values
- referred to data and names.

Skills questions

1. Doughnut charts are used to show:
   a. total populations
   b. ***change*** over time
   c. directions of flow
   d. proportions of a whole.
2. Doughnut charts include information about:
   a. negative values
   b. percentages
   c. ***place*** comparisons
   d. highest values.
3. Why can many divisions make a doughnut chart difficult to read? What can you do to avoid this?
4. How does using Excel make plotting a doughnut chart a fairly simple procedure?

17.8 SkillBuilder: Creating a survey

17.8.1 Tell me

What is a survey?

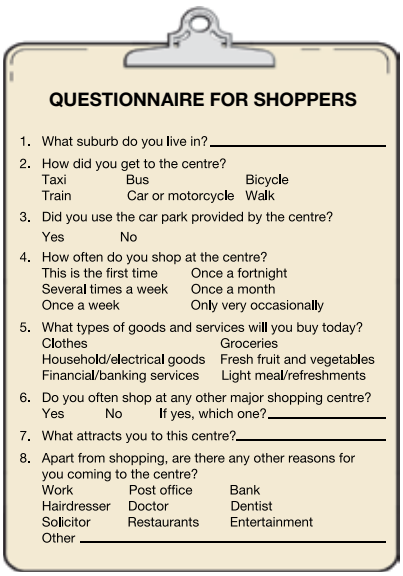
Surveys collect primary data. A survey involves asking questions, recording and collecting responses, and collating and interpreting the number of responses. Because your survey is taken from a relatively small number of people in a population, it is called a sample.

Why are surveys useful?

Surveys are useful because they provide statistics for a specific topic that might not be available by any other means. A wide range of data can be gathered in an efficient and simple way.
They are also useful for:

- counting features in a given area — tourist destinations, houses with air conditioners or traffic flows, for example
- summarising people's activities
- providing a snapshot of people's opinions, values and attitudes
- testing people's perspectives and viewpoints — how they rate a feature, for example.

FIGURE 1 A survey of shoppers



QUESTIONNAIRE FOR SHOPPERS

1. What suburb do you live in? _____
2. How did you get to the centre?
   Taxi Bus Bicycle
   Train Car or motorcycle Walk
3. Did you use the car park provided by the centre?
   Yes No
4. How often do you shop at the centre?
   This is the first time Once a fortnight
   Several times a week Once a month
   Once a week Only very occasionally
5. What types of goods and services will you buy today?
   Clothes Groceries
   Household/electrical goods Fresh fruit and vegetables
   Financial/banking services Light meal/refreshments
6. Do you often shop at any other major shopping centre?
   Yes No If yes, which one? _____
7. What attracts you to this centre? _____
8. Apart from shopping, are there any other reasons for you coming to the centre?
   Work Post office Bank
   Hairdresser Doctor Dentist
   Solicitor Restaurants Entertainment
   Other _____

Model

A good survey:

- has no more than 10 questions
- ensures that each question focuses on one thing
- makes almost all questions closed questions, providing choices for participants to select from
- uses simple and direct language
- includes questions respondents will be able to answer without needing too much time to think
- ensures questions can be answered briefly
- puts questions in a logical order
- has questions that avoid bias
- does not include questions that are of a personal nature
- has data/results that can be summarised.

17.8.2 Show me

How to develop a survey

You will need:

- a computer to set out the questions — this makes organising the questions easier
- suitable computer software.

Procedure:

To develop a survey, you must take the time to create a set of questions relevant to the topic being explored.

STEP 1

Determine the topic that you want to gather data about, and consider why you want this data. In figure 1, the above example, the questionnaire is about shopping habits.

STEP 2

Begin by listing a series of questions. Use a computer so that you can easily modify the wording. Remember these should be closed questions, so they should include a series of answers to choose from. Each question should have four to six responses for people to select from. Examples of these in figure 1 are questions 2 to 5.

STEP 3

Try your questions with a classmate, to see whether the questions are clear and whether they elicit quick, concise responses. If necessary, reword your questions.

eBookplus

eLesson
Creating a survey
Searchlight ID: eles-1764

STEP 4

Discuss the order of questions with a classmate, and review and reorganise the order of the questions if this seems necessary.

STEP 5

Provide one or two open-ended questions to allow the respondent to have their say. These are questions for which the respondent can answer in their own words and give more detail. Question 7 in figure 1 (*What attracts you to this centre?*) is considered open-ended, because a wide range of answers is possible. Word these carefully, because you need to be able to gather the data from all the respondents.

STEP 6

Make sure that you have not asked the respondents anything that is too personal, as you don't want to offend or embarrass people. Reword or delete any questions that you are not sure about.

STEP 7

Check your survey for bias. Bias is when you have unfairly influenced the respondent to your survey. You do not want to lead your respondent in a particular direction and thus skew your research. This is particularly important if the survey is about opinions, values, attitudes and perspectives on issues. For example, question 2 in figure 1 would be considered biased if it asked 'If you didn't come by bus, what transport did you use?'

STEP 8

Review your work before asking people to complete your survey.

STEP 9

When you go out into the field to ask people to respond to your survey, there are a number of guidelines to follow.

- Introduce the survey (what it is, who you are, what you are trying to find out).
- Assure people that you are a student and that their responses will be used only for research purposes and no one will be identified.
- Accept that not everyone will want to talk to you.
- Be sure that you are safe at all times; take no risks and always work with a partner.
- Thank the respondents for their time at the end.

eBook*plus*

Interactivity
Creating a survey
Searchlight ID: int-3382

17.8.3 Let me do it

Developing my skills

Design a questionnaire to discover places that students from your year level, or people in the wider community, have visited as tourists in the past five years. Check the five things you need to find out to help you work out which questions to ask in your survey.

Ask people in your class, year level or local area to complete your survey. When you come back to school, tally your results and see if you can draw some conclusions. Write a paragraph on what your survey has shown you.

Questions

1. Based on responses to your survey, what percentage of people have travelled somewhere as tourists within the past five years?
2. What trends emerged from your survey with regard to the frequency with which people travel within Australia compared to those who travel overseas?
3. Is there a relationship between how far people travel and how frequently they go? Is there a relationship between how far people travel and how long they stay?
4. What were the main recreational activities people were involved in when they travelled to other ***places*** as tourists?
5. Describe the key features of your respondents' travel patterns. For example, were there particular continents or countries, or even regions within countries, that were more popular than others?

Checklist

I have:

- asked no more than 10 questions
- ensured that each question focuses on one thing
- made almost all questions closed questions, providing choices for participants to select from
- used simple and direct language
- included questions respondents will be able to answer without needing too much time to think
- ensured questions can be answered briefly
- put questions in a logical order
- ensured that questions avoid bias
- not included questions that are of a personal nature
- ensured that data/results can be summarised.

Skills questions

1. Surveys are used to gather information that is:
   a. a personal opinion
   b. a summary of ideas
   c. a biased account
   d. a set of untruths.
2. One of the aims of a survey is to find the number of people who:
   a. dislike a topic
   b. have similar ideas on a topic
   c. have varied views on a topic
   d. like a topic.
3. Did your classmates come up with similar questions to yours? Why or why not?
4. How important is the wording of the questions? Give an example in which you and a friend wanted to find out the same information but worded the question differently. Which version was better? Why?

17.9 SkillBuilder: Describing divergence graphs

17.9.1 Tell me

What is a divergence graph?

A divergence graph is a graph that is drawn above and below a zero line (see figure 1). Those numbers above the line are positive, showing the amount above zero. Negative numbers that are shown indicate that the data has fallen below zero.

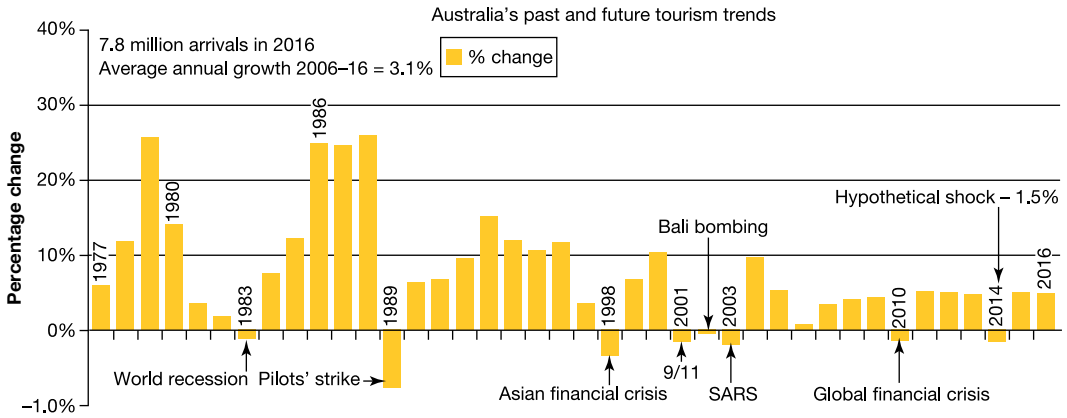
You may have seen graphs with negative numbers in climate graphs, where some months of the year in some places are below 0 °C on average.

Why is a graph with negative numbers useful?

A divergence graph allows you to identify changes away from the normal in a trend. A trend is a common pattern of gradual change. A divergence graph can indicate data that varies considerably over time.

Model

FIGURE 1 Australia's past and future tourism trends



Australia's tourism industry has experienced fluctuating highs and lows for the past 50 years. The 1980s was a period of high percentage change in tourism (20–30 per cent), hit by a world recession and pilots' strike (negative growth) but rebounding strongly afterwards (15 per cent) in the early 1990s. The percentage change in tourism has not been as strong (<10 per cent) since the 1990s. The 1990s saw more growth than the 2000s (5 per cent), when global events had a big impact. More recently, Australian tourism has been affected by the global financial crisis (2010, with negative growth).

A good interpretation of a graph with negative numbers:

- identifies and communicates key features such as patterns, peaks and troughs
- clearly represents and communicates the data, for example about a specific place.

17.9.2 Show me

How to describe a divergence graph

You will need:

- a graph showing trends, including negative trends.

Procedure:

STEP 1

Read the title of the graph carefully to see what data has been graphed, and to check the locations and dates to which the graph refers.

eBookplus

eLesson
Describing divergence graphs
Searchlight ID: eles-1739

STEP 2

Study the labels on both axes and any key or legend provided to add to your knowledge. In figure 1, you can see that the time frame of the information is from 1977 to 2016, and that the number of visitors to Australia is represented on the vertical axis as percentage change.

STEP 3

Study the shape of the graph; in figure 1, you will note that some features are related to global events, such as recessions, pilots' strike, terrorism and disease outbreaks (SARS). At times the graph flattens out as there is little change, such as in the late 2000s.

eBook*plus*

Interactivity
Describing divergence graphs
Searchlight ID: int-3357

STEP 4

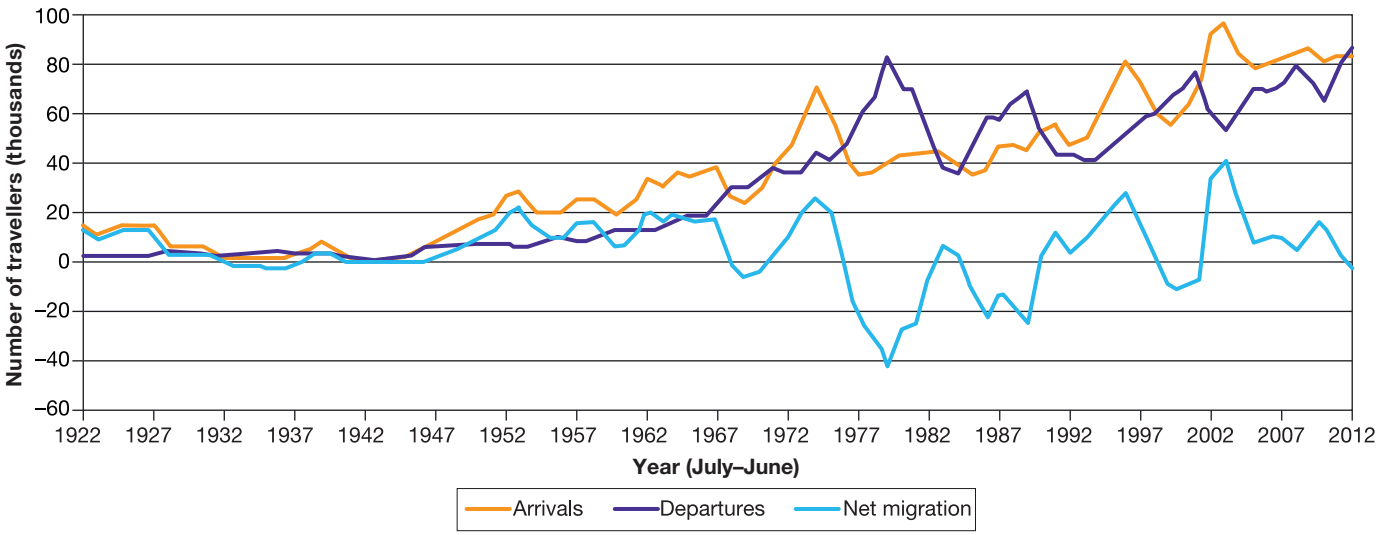
Write a few sentences to outline the shape of the graph; for example, 'figure 1 shows that Australian tourism has experienced fluctuating highs and lows for the past 50 years'. Include any events that affected the change into your description. For example, the text below figure 1 includes the explanation that the 1980s was 'a period of high percentage change in tourism (20–30 per cent), hit by a world recession and pilots' strike (negative growth)'. Also look for periods of time where the change was either slow (2010 in figure 1) or rapid (1989 in figure 1).

17.9.3 Let me do it

Developing my skills

Using the graph shown in figure 2, explain what is happening to the level of migration in New Zealand. Use the net migration line as the basis for your answer.

FIGURE 2 New Zealand migration trends: Annual permanent and long-term arrivals, departures and net migration, New Zealand 1922–2012



Questions

1. What is the trend for the line indicating the number of arrivals?
2. What is the trend for the line indicating the number of departures?
3. In which years did the population of New Zealand lose more people than it gained?
4. Identify a period of time when increases took time and a period when they happened quickly.
5. Identify a period of time when decreases took time and a period when they happened quickly.
6. If net migration is the difference between arrivals and departures, what is happening to people's migratory attitudes with regard to New Zealand?

myWorldAtlas Deepen and check your understanding of this topic with related case studies and auto-marked questions. › Tourism in Australia

Checklist

I have:

- identified and communicated key features such as patterns, peaks and troughs
- clearly represented and communicated the data about a specific place.

Skills questions

1. Divergence graphs are used to show that:
   a. a loss has occurred
   b. variation from the average is negative
   c. less of a product has been produced
   d. production is decreasing.
2. Divergence graphs include information about:
   a. total production
   b. production comparisons
   c. patterns over time
   d. increases in production.
3. What does the zero line indicate?
4. Why is it important to know some of the historical events behind the data for a ***place***?

17.13 Review

17.13.1 Review

1. Use the information in table 1 to complete the activities that follow.

TABLE 1 Tourist arrivals by region, 2011

Region	Tourist arrivals (millions)
Africa	55.6
North America	120.3
Caribbean	22.8
Central America	9.5
South America	28.5
Asia	263.4
Pacific Islands	7.1
Australia	6.8
Europe	581.7
Middle East	51.4

Source: © UNWTO; 9284403213/*UNWTO Tourism Highlights; 2014 Edition*

   a. On a blank outline map of the world (use doc-11392 in the Resources tab), shade the regions listed in the table according to the number of tourists they attracted in 2011, using a different shade of one colour for each of the following categories:
      - 0–30 million
      - 30.1–60 million
      - > 60 million.
   b. What percentage of the world's tourists came to Australia in 2011? What advantages and disadvantages might Australia have in attracting foreign visitors to its shores?
2. Think of a ***place*** in your state that you have visited and that attracts tourists. Describe how this ***place*** has ***changed*** over the last 60 years to cater for tourists. Have these ***changes*** had a positive or a negative impact? Explain. Describe the ***interconnection*** between people and ***places*** and ***change*** over time.
3. If tourism does not significantly harm or ***change*** natural or cultural ***environments***, does this mean it is ***environmentally sustainable***? Explain.
4. Working in groups, use what you have learned in this chapter to complete the following. You and three of your friends have won the ultimate holiday adventure. Your prize allows you to plan your own itinerary with the following conditions attached.
   - You cannot travel more than 60 000 kilometres.
   - You can travel in only one direction around the world and can make only ten stops on your journey.
   - Stop 10 will be the airport from which you departed.
   - If you include a cruise as part of your itinerary, each time you get off the ship in a new country, this is counted as a new destination.
   - Your journey must be plotted on a map and presented as a slide show.
   - You must include the following in your itinerary:
     – a country that attracts a lot of tourists
     – a country that attracts few tourists
     – one of the world's natural wonders
     – an ecotourism resort
     – a cultural event
     – a sporting event
     – a cold environment
     – a hot environment
     – a medical tourism destination.

Is development necessary?

A proposal has been put forward to rezone about 1155 hectares of land across 20 sites, including some along the Great Ocean Road, in order to expand tourism accommodation and facilities. The plans include the development of four- and five-star resort-style accommodation in an environmentally sensitive region renowned for its breathtaking views. Those in favour of the development say that the region is the third most visited tourist site in the country but the lack of high-end accommodation and facilities means that the region does not benefit significantly in financial terms from its attractions.

FIGURE 1 Priority projects in the Great Ocean Road region



Source: Spatial Vision

1. **Lake Condah/Budj Bim National Heritage Landscape**
   - Restoration of Lake Condah church site as a place of reconciliation and healing
   - Development of an international learning centre at Lake Condah
   - Development of employment and enterprise activities focused on tourism accommodation, aquaculture, bush tucker and supporting industries

2. **Great Ocean Road integrated resort**
   - Large bistro/restaurant
   - Self-contained accommodation
   - Hotel accommodation
   - Cabins
   - Tourist park facility for vans
3. **Port Campbell precinct and Loch Ard interpretive centre**
   - Loch Ard interpretive centre
   - Improved interpretation, trails and other infrastructure at other locations (Bay of Islands)
   - Apostle trail
   - Food merchandising with views
   - Merchandising
4. **Great Ocean Walk**
   - New trails investment
   - Improvements to existing trail network
5. **Great Ocean Road signature accommodation**
   - 25 luxury suites
   - Day spa
   - Restaurant
   - Guest lounge and bar
6. **Great Ocean Road upgrade**
   - Increased safety improvements
   - Improvements to areas where landslips occur
   - General maintenance, pruning of trees and grooming of vegetation
   - Shoulder sealing for cyclists
   - Improvements to road reserves
7. **Geelong Convention and Exhibition Centre**
   - Plenary capacity of 1000 delegates
   - Exhibition hall of 3000 square metres
   - Break-out rooms
   - Multi-purpose format to accommodate small- to medium-size events
   - Provision of a 4-star hotel of 150–200 rooms as part of the complex
8. **Avalon Airport upgrade**
   - 7500 square metres of new international terminal proposed

5. Use the map to describe the ***scale*** of the proposed ***changes*** to the Great Ocean Road region.
6. Explain what is meant by the term resort-style accommodation.
7. Do you think these ***changes*** will have a positive or negative impact on the ***environment*** in these ***places***?
8. Do you think this proposal is an example of ***sustainable*** tourism? Explain.
9. Write a letter to the editor expressing your views on these proposed ***changes*** and the consequences they might have for people and ***places***.

17.13.2 Reflect

Are tourism development and conservation compatible?

Development and conservation are complex issues and often have competing needs. Once, endangered species were threatened by poachers, but now it is the tourists and animals themselves that require careful monitoring. In Africa, for example, wildlife reserves often have luxury accommodation attached. They give tourists the opportunity to experience natural environments and go on safari, where they are encouraged to 'shoot' animals using cameras rather than guns. However, the presence of too many tourists places a strain on the natural resources of a region. Roads, vehicles and the people they bring damage grasslands and can interfere with the nomadic way of life and culture of local communities. While elephants are an important component of the grassland ecosystem, too many can turn the grasslands into a desert wasteland.

10. Why do you think balancing the needs of tourists and natural ***environments*** requires careful planning?
11. In groups, investigate Madikwe Game Reserve, Kruger National Park or another similar area in Africa that you are aware of.
    a. What is the ***interconnection*** between ***sustainable*** management, the ***environment*** and tourism development in the ***place*** you have investigated?
    b. Prepare a map of the area your group has investigated. Annotate your map with suggestions for ***sustainable*** strategies to cater for the needs of people and the ***environment*** in this ***place***.

FIGURE 2 When elephant numbers exceed the carrying capacity of the land, they can cause considerable damage to the environment.



CHAPTER 18

Technology connecting people



Technological interconnections

18.1 Overview

18.1.1 Introduction

Transport and technology connect people and places, enhancing access to goods, services and information. Developments in transport technologies have resulted in a shrinking world with vastly reduced travel times and costs. Our ability to communicate has been transformed by technology. While the benefits of these developments are enormous, these benefits are not equally shared, and with the advantages comes a range of consequences that must be addressed.

Starter questions

1 In what ways do you benefit from technology in your daily life? How does technology assist you in communicating in your day-to-day life?
2 Is technology integral to maintaining your relationships?

Inquiry sequence

		Syllabus outcomes
18.1 Overview		
18.2 Transport and technology		GE4-2, GE4-3, GE4-5
18.3 Investigating topographic maps: How do we use Port Botany?		GE4-2, GE4-3, GE4-4, GE4-5
18.4 Transport connecting people with places		GE4-2, GE4-3, GE4-5
18.5 Differences in connections of people and places		GE4-2, GE4-3, GE4-5
18.6 SkillBuilder: Interpreting topological maps	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-5
18.7 How do we communicate?		GE4-2, GE4-3, GE4-4, GE4-5
18.8 ICT and increased connection to services and information		GE4-2, GE4-3, GE4-4, GE4-5
18.9 ICT and increased connection to people		GE4-2, GE4-3, GE4-4, GE4-5
18.10 Impacts of global connectivity on people and places		GE4-2, GE4-3, GE4-4, GE4-5
18.11 SkillBuilder: Constructing and describing isoline maps	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-4, GE4-5
18.12 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Making connections
Searchlight ID: eles-1722

ten pound Pom the name given to British migrants who migrated to Australia after World War II. The fare to Australia was subsidised by the Australian government and cost only £10.

Hummer a type of car originally built for use by the US army; they are now often used in cities as stretched limousines

18.2 Transport and technology

18.2.1 Transport changes

When European settlement occurred in Australia a little over 225 years ago, it took people eight months to make the voyage by boat. After World War II, a new policy saw the advent of the '**ten pound Pom**', an assisted immigration scheme that allowed people from Britain to travel by boat to Australia for 10 pounds ($20). That journey took eight weeks. An average individual travelling on one of the earliest commercial flights on a return journey between London and Sydney would need to spend two and a half years salary. By 2015, this had been reduced to just eleven days salary for the same return journey.



FIGURE 1 Inflight entertainment

18.2.2 Planes

Air travel has become increasingly more accessible in the past 30 years. Once a luxury item, only for the upper classes, air travel has become more accessible over time. The increased size of aircrafts such as the A380, the largest passenger airline in production, along with the growth of low cost airlines such as Jetstar, EasyJet and Air Asia X, is responsible for the rapid increase in accessibility to average consumers. Some of the benefits are:

- greater numbers of passengers able to travel at once
- online access to information on discount tickets and travel information
- reduced travel times
- increased comfort
- increased reliability and aircraft safety
- better services (such as inflight entertainment; see figure 1).

FIGURE 2 An advertisement for a Model T Ford. In order to speed up the production process, Henry Ford started to produce only black cars, famously saying 'Any customer can have a car painted any colour that he wants so long as it is black'.



18.2.3 Automobiles

The car has come a long way since the first Model T Ford rolled off the assembly line in Detroit, USA, in 1908 — it was the first mass-produced vehicle (see figure 2). Today there are over 105 car manufacturers worldwide with some of these offering between 15 and 30 different models of new vehicles every year. The changes to car manufacturing and design over the years have seen cars continue to become more comfortable and connected, and more suited to a greater variety of people's needs. With an overdependence upon oil and dwindling supplies of this finite resource, there is now a shift in manufacturing away from big high-consumption vehicles towards more energy-efficient cars such as a Prius or Tesla (see figures 3 and 4). The **Hummer**, with its high fuel consumption, is no longer in production.

FIGURE 3 Tesla charging



FIGURE 4 Tesla promotion

Tesla electric motors have only one moving piece: the rotor. As a result, Model S acceleration is instantaneous, silent and smooth. Step on the accelerator and in as little as 3.0 seconds Model S is traveling 100 km per hour, without hesitation, and without a drop of gasoline. Model S is an evolution in automobile engineering.

Source: Tesla.com.au

18.2.4 Shipping

With globalisation connecting consumers and producers more than ever before, advancements in shipping, and the growth of the maritime industry have been at the heart of driving this growth. The growth in the transportation of dry goods alone has increased from 1162 million tonnes in 1970 to 6704 million tonnes in 2014. Today, super container ships are found operating out of every major port on Earth, and are now able to carry up to 18 000 containers each. If you were to stack the containers from a single ship in a line they would reach from the Sydney Opera House to either Merewether beach in Newcastle, Lithgow past the Blue Mountains or Seven Mile Beach in Shoalhaven, a distance of almost 110 kilometres. The unit of measurement used to show a ship's cargo-carrying capacity is TEU (see figure 5 and table 1). One unit is equal in width to a standard shipping container.

FIGURE 5 Growth of container ships

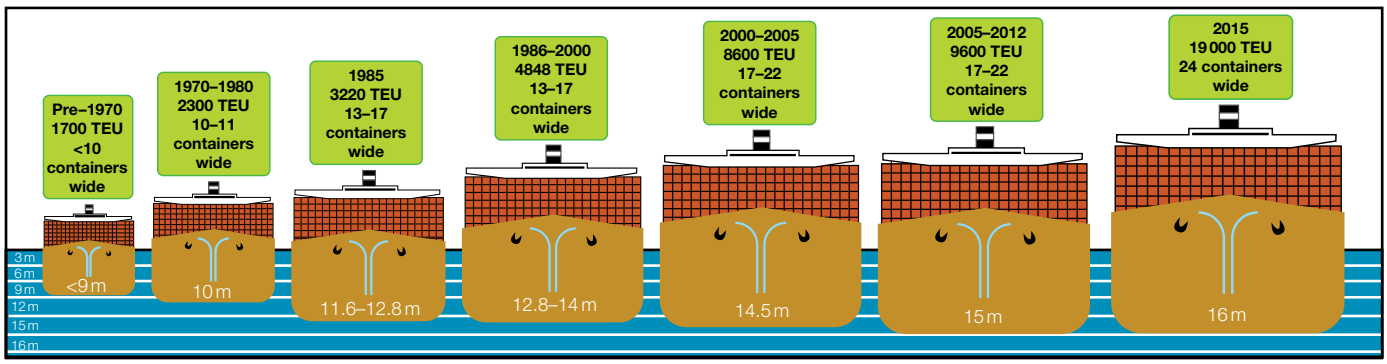




TABLE 1 Largest ports in the world by volume of containers

Rank	Port and country	Volume (million TEU) 2014
1	Shanghai, China	35.28
2	Singapore	33.9
3	Shenzhen, China	24.03
4	Hong Kong, SAR, China	22.30
5	Busan, South Korea	19.45
6	Ningbo-Zhou Shan, China	18.65
7	Qingdao, China	16.62
8	Guangzhou Harbour, China	16.16
9	Jebel Ali, Dubai, United Arab Emirates	15.24
10	Tianjin, China	14.05

ACTIVITIES

IDENTIFY

1 What are the benefits of the ***changes*** to planes and air travel?

EXPLAIN

2 Why did it take so much longer to afford to fly in the period just after World War II compared to 2015?

3 Look at figures 3 and 4 and suggest why Tesla is a growing car company and why Hummer no longer exists.

APPLY

4 Look at table 1 and identify which country has the most ports in the top 10. Suggest implications for this country as well as for other countries such as Australia.

5 a Refer to figure 5. How many pre-1970 ships would be needed to carry the same number of containers as a ship built after 2012?

b Why have the changes occurred to these ships and what are the impacts (positive and negative)?

INVESTIGATE

6 Look at figure 2. Why did Henry Ford start to make cars in only one colour?

18.3 How do we use Port Botany?

18.3.1 Port Botany

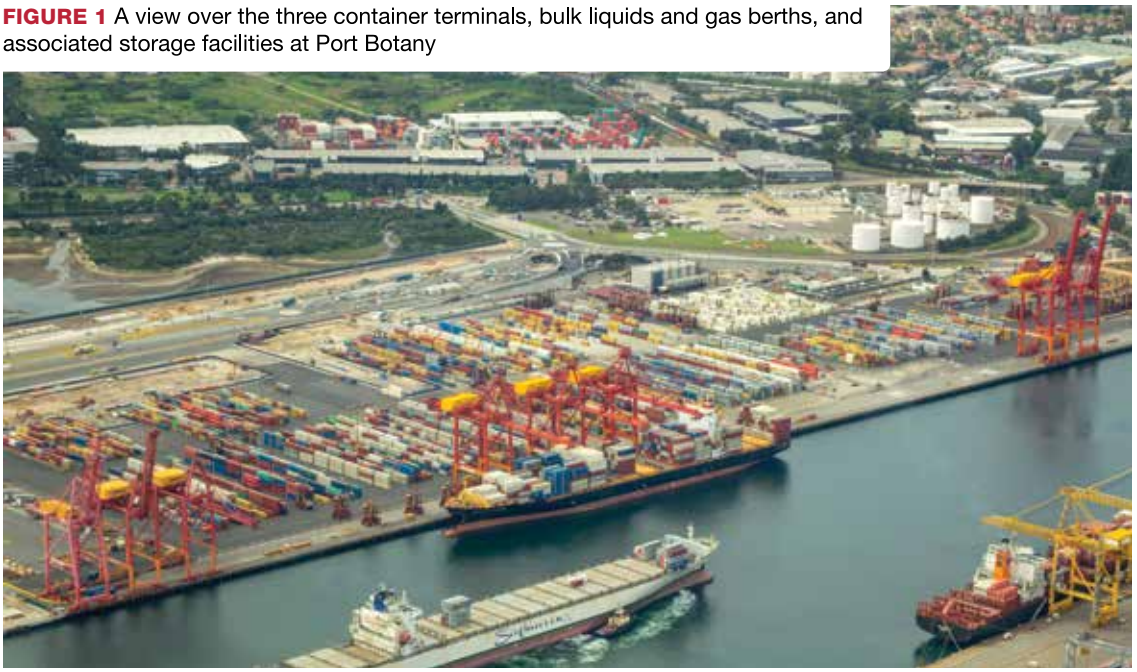
Port Botany, located in Botany Bay, is the major shipping port in Sydney and New South Wales. It is Australia's second largest container port. Some of the Bay has needed to be dredged to provide ships with deep water channels to pass through while land has been reclaimed to provide land on which to build the port.

18.3.2 Trade facilities and links

Today Port Botany covers an area of 237 hectares and consists of three container terminals, a bulk liquids and gas facility, and a bulk liquids storage and distribution complex that is connected to underground pipelines. These pipelines include aviation fuel to Sydney Airport, and chemicals and gas to nearby Botany Industrial Park.

Cargo moves through Port Botany either to or from over 170 overseas countries. The port is adjacent to the Port Botany Freight Line, a dedicated rail freight line for container freight distribution and collection of export containers from regional areas of New South Wales. Over 80 per cent of import containers through Port Botany are delivered within a 40 kilometre radius of the port.

FIGURE 1 A view over the three container terminals, bulk liquids and gas berths, and associated storage facilities at Port Botany



ACTIVITIES

IDENTIFY

1. Calculate the length of train track from Port Botany to the junction at GR 354413.
2. What evidence is there that Port Botany is well serviced by road transport facilities?
3. What is the main physical feature at La Perouse point in AR3637?
4. What is the gradient between the spot height adjoining the Macquarie Watch Tower in AR3637 and the bulk liquid storage facility in AR3439? Why would the gradient of an area be an important consideration when establishing a port?
5. What is the area of the Port Botany container terminal south of Brotherson Dock and bound by the rail line, Friendship Road and Charlotte Road?
6. What feature is located at GR347393? Why is it located there?

APPLY

7. Ports are used to transport both imports (goods coming into a country) and exports (goods leaving a country). What is the major item stored south of Friendship Road? Do you think this would be for importing or exporting? Justify your answer.
8. Sydney's Kinsgford Smith airport is located about 7 kilometres north-west of Port Botany. Why do you think they chose to locate the airport there?

FIGURE 2 Topographic map extract of Port Botany



Source: Land and Property Information, NSW.

18.4 Transport connecting people with places

18.4.1 Public transport

Public transport provides a relatively low-cost way for people to interconnect with places, and can reduce traffic congestion and pollution. For students, it is often the only way to get around. Sometimes, however, it can seem like too much bother, perhaps because one service does not connect to another or because there are not enough services running, especially near your house.

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communications systems, water pipes and power lines

Public transport use is considerably higher in capital cities than in other parts of Australia, partly because cities have relatively large populations and better public transport **infrastructure**. But how satisfied are we with our current public transport provision? Figure 1 provides some answers, at least for people in the Sydney region.

18.4.2 Our changing needs

With any population growth, governments at all levels must consider how they will meet changing transport needs. ICT developments have allowed us to make better decisions for our use of public transport. For example, have you used the internet or an app to find the fastest way to get from A to B? Service quality, frequency and infrastructure are generally the biggest concerns in the provision of a public transport system. However, the affordability of public transport is equally important, because many low-income people depend upon public transport to access jobs, services, education and recreation.

patron a customer, especially a regular one

mobility the ability to move or be moved freely and easily

Sydney has the highest rate of public transport usage among the Australian capital cities, with 26.3 per cent of people being regular **patrons**. Its users make the most of bus, rail and ferry options to commute to work and study. A community group, the Sydney Alliance Transport Team, has a vision for a world-class public transport system in Sydney — one that is regular, reliable, clean, safe and easy to use, regardless of health, wealth, age or **mobility**. It would be planned, integrated and connected to where people live, work and play, and would satisfy the following equation:

$$400{:}15{:}1\ SCA^2$$

This equation means:

- access to transport is within 400 metres
- transport arrives every 15 minutes
- it requires only 1 ticket
- it is **s**afe, **c**lean, **a**ccessible and **a**ffordable.

Figures 2 and 3 show the results of some of the Sydney Alliance Transport Team's research into how well Sydney is satisfying this vision.

FIGURE 1 Satisfaction with transport in Sydney, 2014

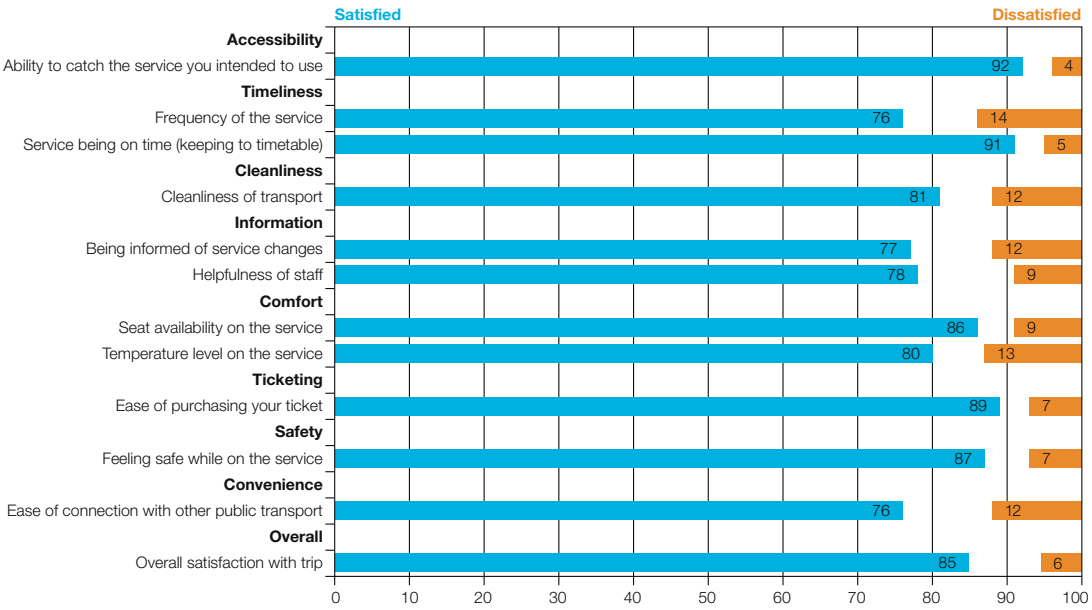


FIGURE 2 In this map, those who live within the pink shaded areas have some form of public transport within 400 metres of their residence.

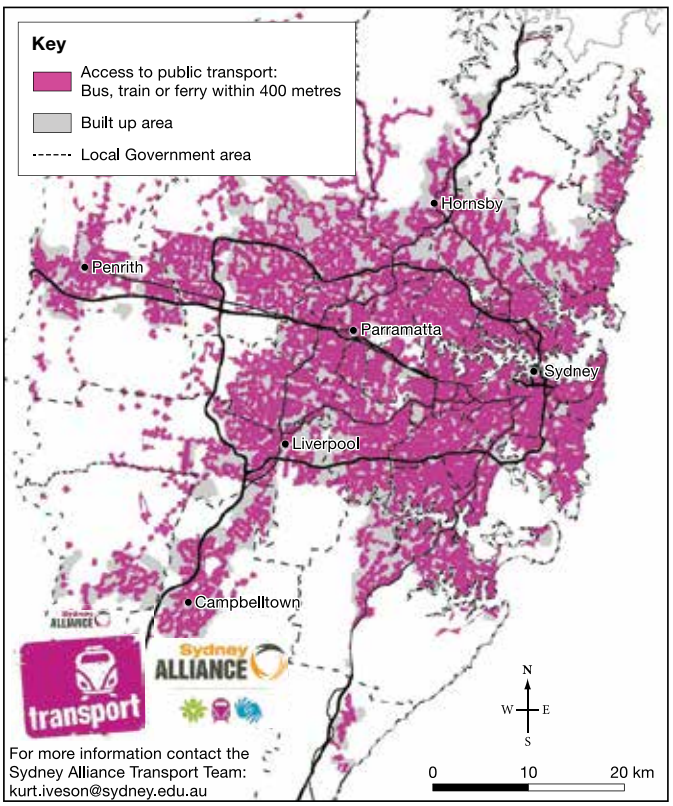
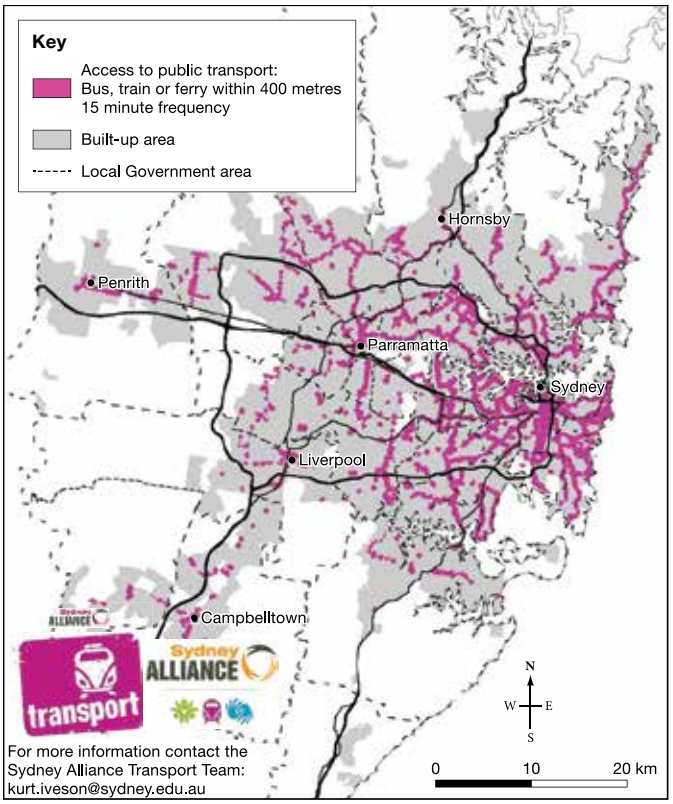


FIGURE 3 In this map, those who live within the pink shaded areas have some form of public transport within 400 metres which also arrives at least every 15 minutes during the day.



Public transport is one of the key components used when compiling liveability scores for suburbs and cities. Many suburbs that score poorly overall or that have low rankings receive these scores because they do not possess the same levels of infrastructure and public transport as other suburbs. This is usually because older, more established suburbs have existing networks and tend to be located closer to major centres of trade and entertainment.

ACTIVITIES

IDENTIFY

1 Refer to figure 1. What are some aspects of Sydney's public transport that users are satisfied or dissatisfied with? Provide examples, using data to support your answer.

EXPLAIN

2 Do you use public transport? Why or why not?

3 a How ***interconnected*** is the ***place*** in which you live? What types of public transport are available to you? What distances do you need to travel to reach a bus stop or a train station?

b What types of public transport are required for you to access your closest international airport?

INVESTIGATE

4 a As a class, pick a location on the other side of town. Using your rail, bus or other public transport provider website, find out how long it would take to travel from your school or home to this point on:
- a Monday morning at 9.00 am
- a Sunday evening at 6.00 pm.

b What did you notice about the travel times? Were they different? Why do you think this is the case? Create a map of your journey, using an appropriate key to show rail, bus and other modes of transport.

APPLY

5 Refer to figures 2 and 3. Although most areas of Sydney have public transport within 400 metres, very few have services running every 15 minutes. What does this mean for people who live in those ***places*** without a regular service? How would it affect their daily lives?

6 Consider the Sydney Alliance Transport Team's vision. Do you think it will be possible to achieve their goal of ***interconnectedness***? What measures will need to be put into place to ensure they can satisfy their vision?

eBook*plus*

Interactivity
Off the rails
Use this interactivity to compare public and private transport across selected cities.
Searchlight ID: int-3333

18.5 Differences in connections of people with places

18.5.1 Public transport in Perth, Melbourne and Copenhagen

Despite the best efforts of governments and service providers, there is no doubt that some people are better connected by public transport than others. 'Black spots' for public transport leave many without access to essential services, and they can force people into cars because there simply are no alternatives.

liveable city
an informal name given to cities if they rank highly on a reputable annual survey of living conditions

Perth, Melbourne and Copenhagen are three of the world's most **liveable cities**, but they have three very different public transport systems.

Figure 1 shows us the average number of public transport trips per capita per year in a number of cities that have been ranked as among the world's most liveable in recent years. The average across these 14 cities is also shown in figure 1. Figure 2 shows the length of roads per capita in the same cities, and the average for those cities. Australian cities, which are generally larger in size and sprawl, do not rate well in either of these areas. Table 1 compares the three cities in terms of size, population, intensity of public transport services, and the number of residents who live within 30 minutes of an **activity hub**. Figure 3 shows us how well Melbourne is achieving network coverage — that is, which areas of Melbourne are interconnected by public transport and which are public transport black spots. Below figure 3 is an excerpt from a study of the frequency of public transport and travelling speeds.

activity hub
a centre for business activities that may or may not be the central business district

FIGURE 1 Number of public transport trips per year, per person, in the world's most liveable cities

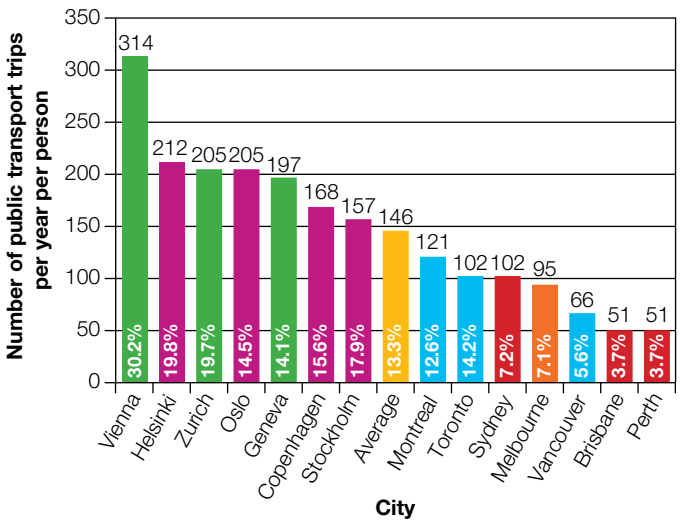


FIGURE 2 Length of roads per person in the world's most liveable cities

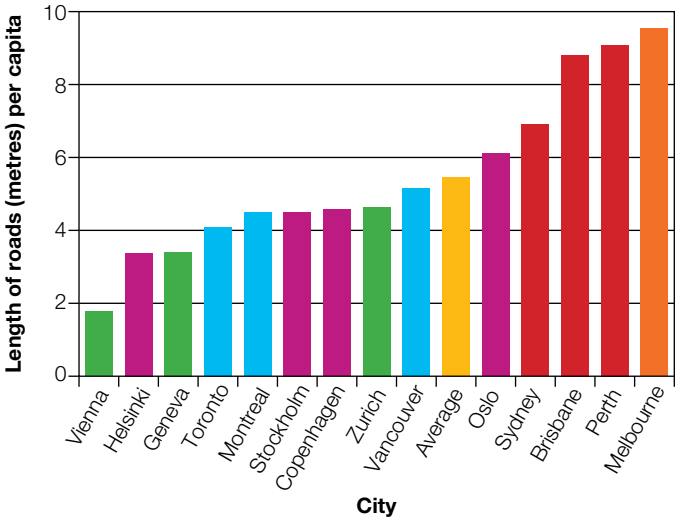
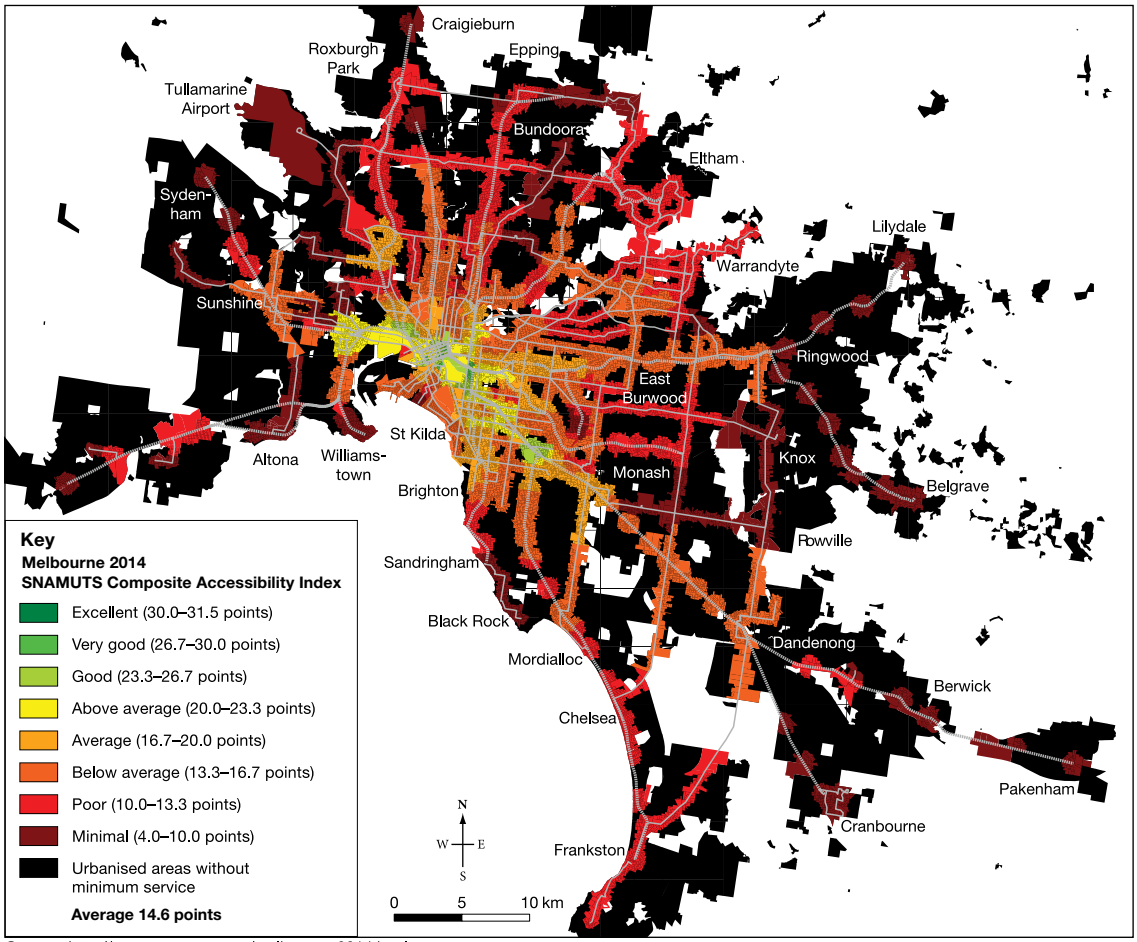


TABLE 1 Key data for three liveable cities

Indicator	Perth (2011)	Melbourne (2011)	Copenhagen (2012)
Residents in metropolitan area (million)	1.73	4.00	1.85
Residents and jobs per hectare (higher = denser)	22.9	28.3	34.7
Average number of residents and jobs within 30-minute public transport travel time from an activity hub	10.6%	9.3%	29.7%

Source: Curtis, C. and Scheurer, J. *Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS)*

FIGURE 3 Melbourne's public transport accessibility



Source: http://www.snamuts.com/melbourne-2014.html

eBook*plus*

Interactivity
City connections
Use this interactivity to determine how accessible various places are to cities.
Searchlight ID: int-3334

Both Copenhagen's population and the length of its suburban rail network are about half the size of Melbourne's. But while Melburnians need to arm themselves with a veritable library of timetables if they wish to make liberal use of their train system, Copenhageners merely need to memorise three figures (such as 14, 34, 54) for the minutes past the hour trains depart [from] their station — for 20 hours a day, every day. During business hours, the 20-minute frequency is increased to 10 minutes on all routes, and express services with fixed stopping patterns operate on most of the network throughout the day. Commercial speed across the network is 51 km/h (Melbourne: 40 km/h), and every resident uses the system 53 times per year on average (Melbourne: 38).

Source: *The Economic Benefits of Investing In Public Transport in Melbourne* by Jan Scheurer, Jeff Kenworthy, Peter Newman

ACTIVITIES

IDENTIFY

1 Refer to figure 1. In which cities are the most and fewest public transport trips made per person?

EXPLAIN

2 Refer to the text extract in this section.
- **a** Explain how Copenhagen and Melbourne rail networks differ. You may wish to refer to the size and ***scale*** of the system or the density of service.
- **b** Do you think it is easier or harder to travel on Copenhagen's rail network, compared with Melbourne? Explain your answer.

INVESTIGATE

3 Using the internet, locate maps of the railway networks of Perth, Melbourne and Copenhagen. Note the ***scale*** of the maps. Can you identify the major differences? Look closely at the shape of the rail network. Is it radial? Does it have clusters? Is there a strong ***interconnection*** present between rail lines? Are there noticeable black spots where no rail lines seem to travel?

APPLY

4 The federal and state governments continue to invest in new infrastructure. You can see from the data in figure 2 that Australian cities seem to have many more kilometres of roads than European cities.
- **a** What reasons could contribute to these differences?
- **b** Find out about a new road project in your city or community. What are the ***environmental*** impacts of building new roads? Why do we need them? You may choose to divide into two teams, planners and eco-warriors, and present different views to the class.

eBook*plus* ONLINE ONLY

18.6 SkillBuilder: Interpreting topological maps

What is a topological map?

Topological maps are very simple maps, with only the most vital information included. These maps generally use pictures to identify places, are not drawn to scale and give no sense of distance. However, everything is correct in its interconnection to other points.



eLesson

Watch this video to learn how to interpret a topological map.



Searchlight ID: eles-1736

Interactivity

Try this interactivity to learn how to interpret a topological map.



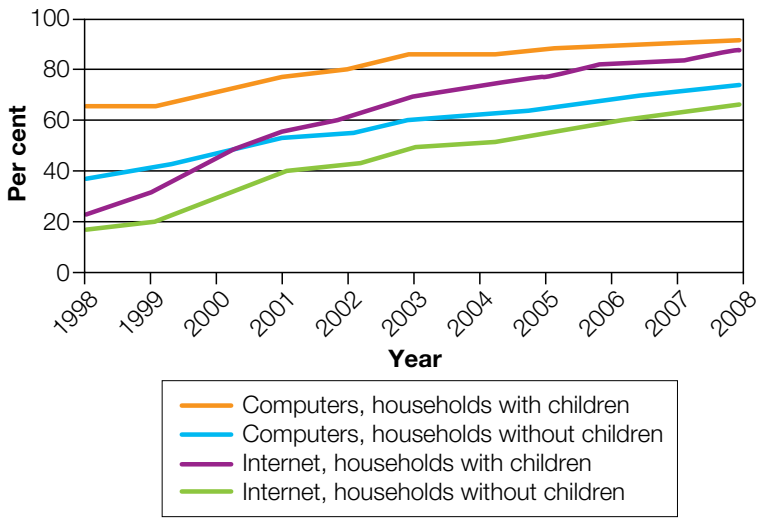
Searchlight ID: int-3354

18.7 How do we communicate?

18.7.1 How do we use the internet?

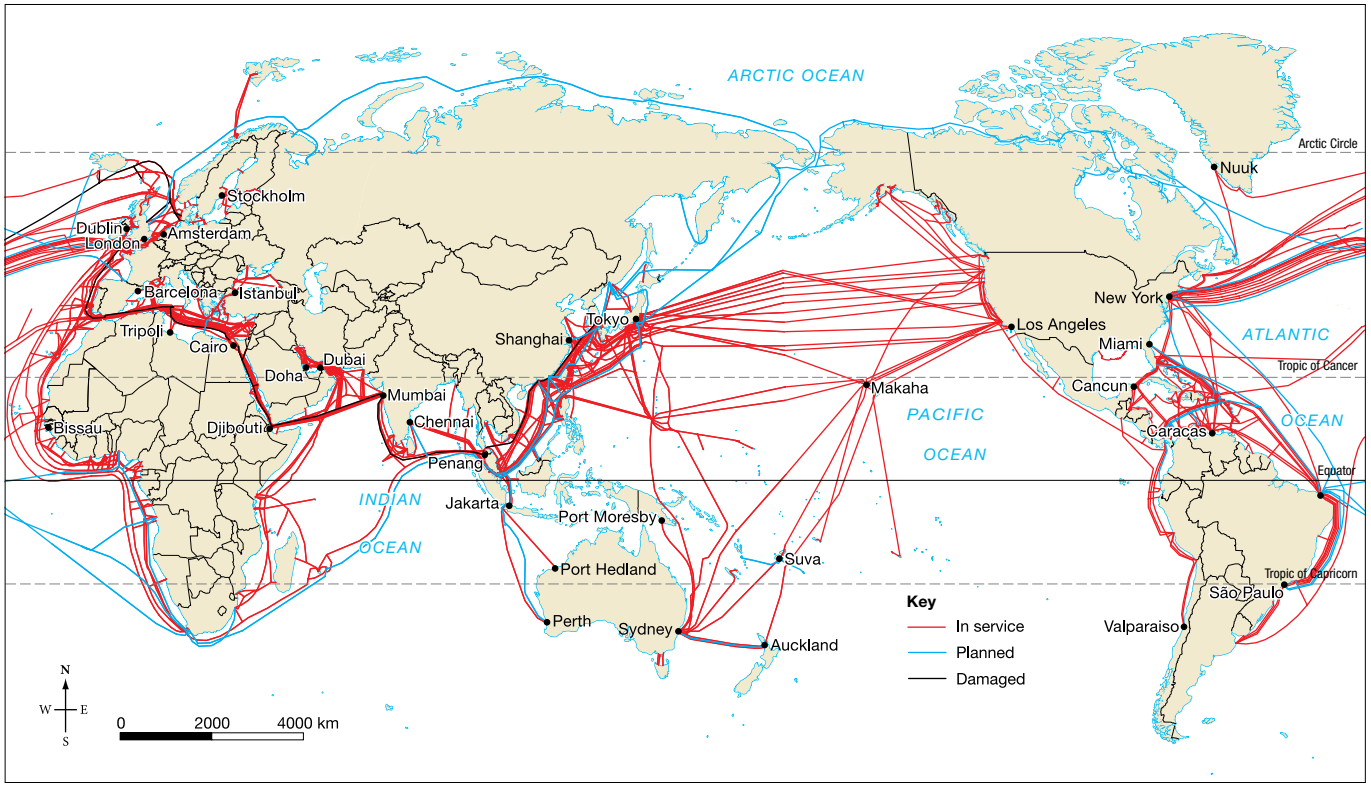
Youth culture is strongly linked to the use of communication technology. More than 800 million adults in the world lack basic literacy skills, yet the boom in information and communication technology is skyrocketing. A survey of 12-year-olds showed that in 97 per cent of the countries surveyed, the inhabitants received at least one television channel. However, less accessible were personal computers (23 per cent) and the internet (9 per cent). Internet use among youths in developed countries is increasing at a rapid rate.

FIGURE 1 Household computer and internet access



Internet access in Australia is continually changing. Both the number of people and the ways in which people access the internet are changing. This is reflective of new technology and greater access for more people (see figure 1). Internet communication is not just done via satellite. There are also fibre optic cables under the sea that help link the network of networks that is the internet, as shown in figure 2. These cables improve the speed of the internet in Australia. New cable, that connects Australia to the United States via New Zealand, has assisted in the creation of the national broadband network (NBN). (See also subtopic 20.6.)

FIGURE 2 The location of underwater fibre optic cables, which help connect the world's internet network



Source: Spatial Vision

18.7.2 Web 1.0, 2.0 and 3.0.

The World Wide Web is a way of accessing and spreading information on the internet. The original **web 1.0** was considered to be read only (see figure 3). Web 1.0 allowed users only to search and read information. **Web 2.0** technology enabled the sharing of online information and ideas that anyone has created. It was the second generation of the World Wide Web, and enables collaboration and exchanging of information online. Web 2.0 is popular because it is an easy form of communication technology to use. Different types of web 2.0 applications include Facebook and YouTube.

Web 3.0 or the Semantic web is the latest progression and allows for greater understanding and mobile connection. For example, if you use your browser to search for a particular song online, the next time you open that browser and start searching you will be given suggestions based on your likes and those of other people with similar interests. The key features of web 3.0 are:

- real-time
- ubiquitous (always connected, always with you)
- location aware
- sensors
- tailored, smaller screen
- high-quality camera and audio.

web 1.0 read-only version of the web. It enabled users only to search and read information.

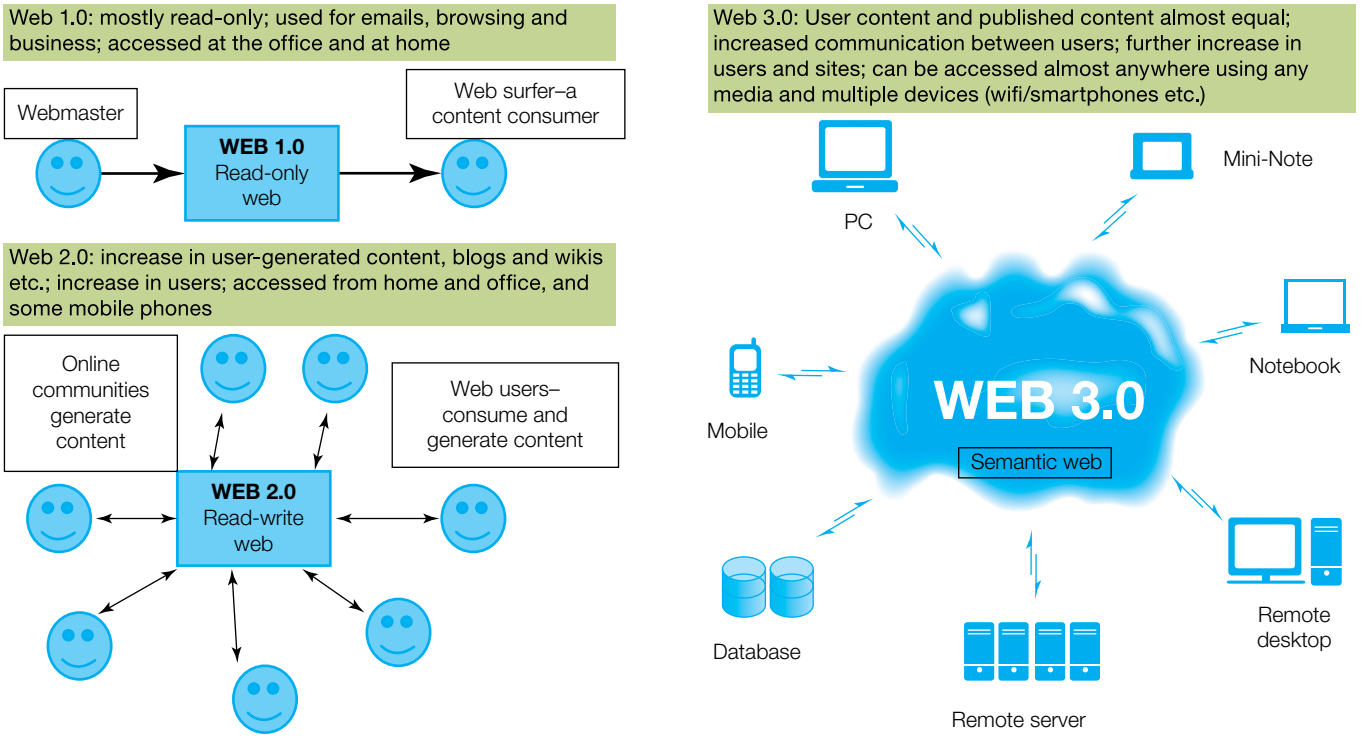
web 2.0 version of the web that allows the sharing of online information and ideas that anyone has created. It is the second generation of the World Wide Web that enables collaboration and exchanging of information online.

web 3.0 current version of the web. Focus is on connective intelligence; connecting data, concepts, applications and ultimately people.

18.7.3 Mobile phones

Mobile phones are a form of wireless communication that is transmitted via radio wave or satellite transmission. Smartphones are now a source of almost endless information. They are essentially pocket computers. Mobile phones bridge the domains of communication and information technology.

FIGURE 3 Web 1.0, 2.0 and 3.0

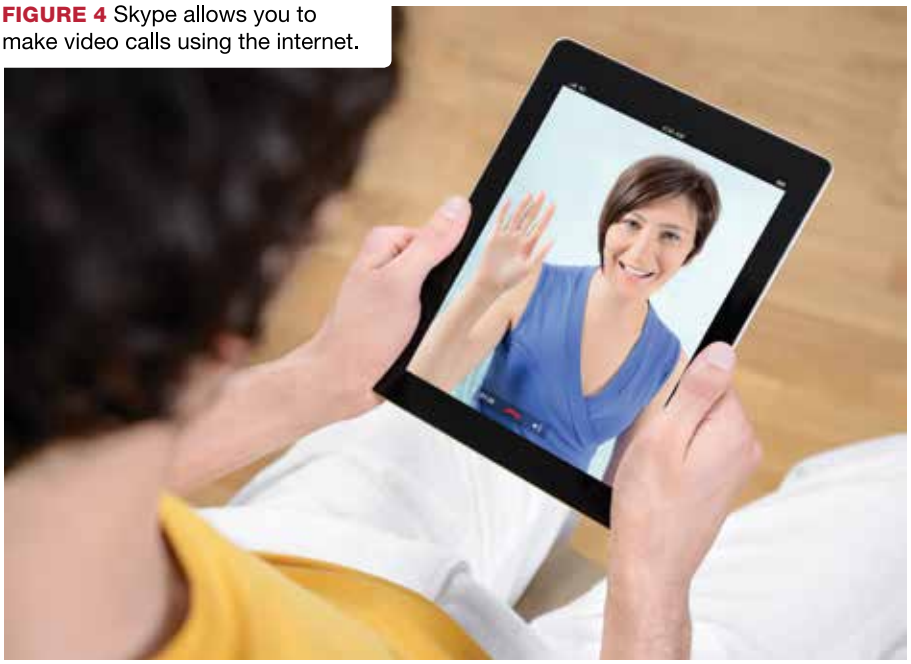


18.7.4 Information and communication technology

Information and communication technology is now used for a variety of purposes to make connections. We often do not realise how convenient our lives have been made by various forms of communication. Some of these include online and telephone banking, storing and sharing of medical records, online shopping and online games.

Skype is another example of an online communication medium — this service makes it possible for anyone with an internet connection to converse in the form of a video call with someone else anywhere in the world. Skype is also available as a mobile phone application, allowing users to have more interactive and cheaper communication. This simple form of communication technology improves the interconnectedness of places around the globe.

FIGURE 4 Skype allows you to make video calls using the internet.



eBook*plus*

Interactivity
www
Use this interactivity to learn more about how the web interconnects the world.
Searchlight ID: int-3341

ACTIVITIES

IDENTIFY

1 Refer to figure 1. How did the percentage of internet access change in households with children between 1998 and 2008?

2 Refer to figure 2. How does the number of submarine cables in Australia compare with the number in Japan?

EXPLAIN

3 Refer to figure 2. Explain the geographical pattern of underwater cables worldwide. Where are the greatest concentrations of cables? Which parts of the seas or oceans seem to lack cables? Why do you think this is?

INVESTIGATE

4 Refer to figure 3. Find out more about how web 1.0 differs from web 2.0 and web 3.0, and create a PowerPoint presentation to compare and contrast them.

PREDICT

5 Predict how the ***interconnectedness*** between Asia and Australia will ***change*** in the future. What do you think it will be based on?

6 Predict what you think will happen to low-income countries' access, quality and usage of information and communication technology.

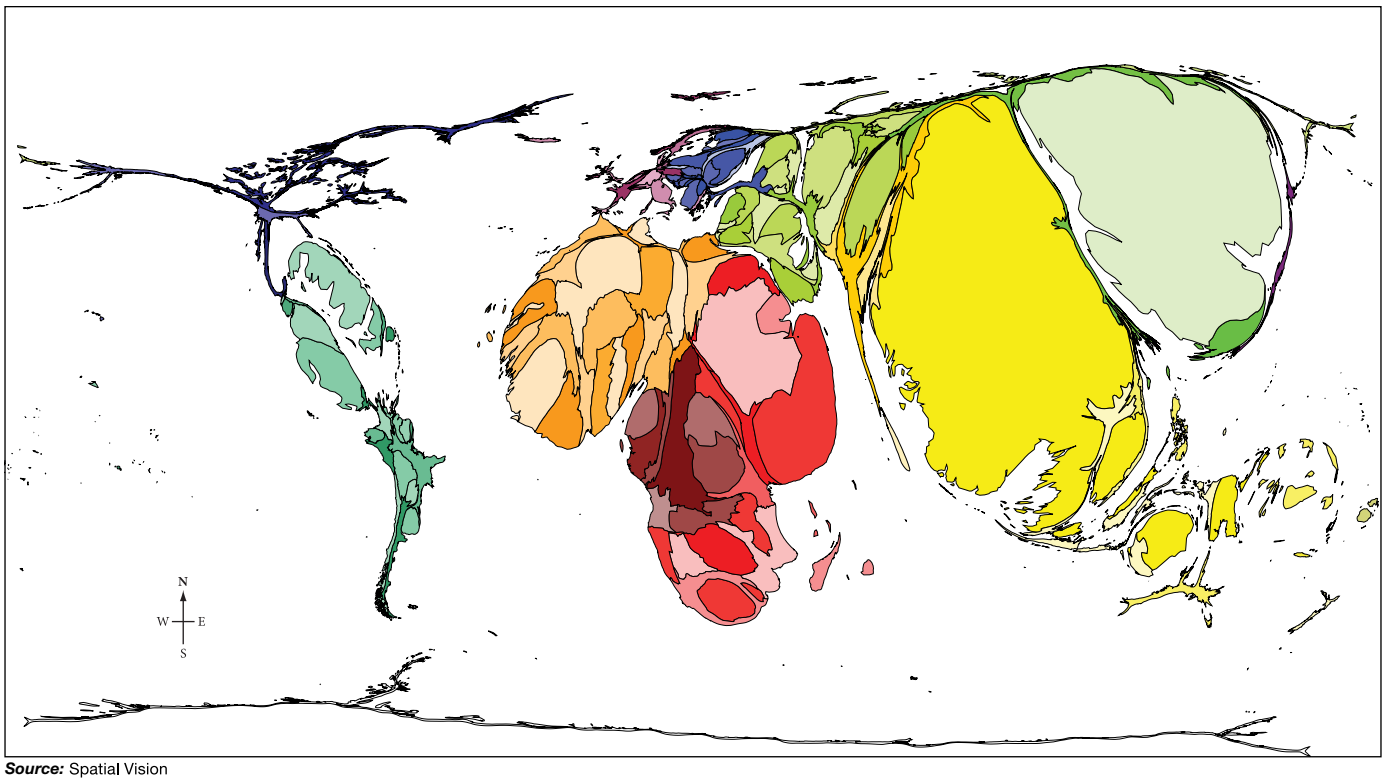
18.8 ICT and increased connection to services and information

18.8.1 Who owns mobile phones?

The growth of information and communication technology has had a significant impact on the way people are able to access online services. However, access to these services is not always equal between countries, let alone within them. Government spending on the infrastructure needed to access ICT has an influence on connecting people to services.

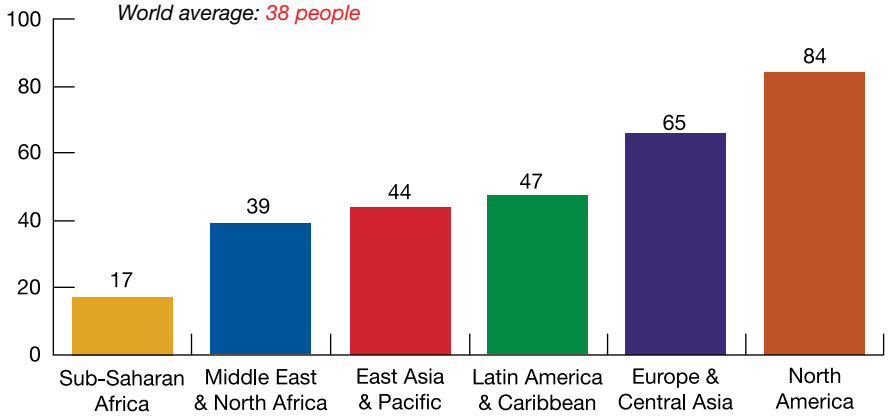
While factors such as way of life and financial situation impact on mobile phone use, there has been a global shift in mobile phone ownership (see figure 1). Many developing countries have bypassed building infrastructure to support landlines and have simply moved straight to mobile phones. It is estimated that over 70 per cent of the 5 billion mobile cellular telephone subscriptions reside in low- and middle-income countries.

FIGURE 1 Cartogram showing changing global mobile phone use



Source: Spatial Vision

FIGURE 2 Internet users by world region (per 100 people)



Mobile phone use worldwide varies considerably. Similarly, there are differences in numbers of internet users, by world region (see figure 2) or by country. North America has the greatest number of internet users. However, on a national basis, the numbers of internet users in China and India are growing rapidly.

18.8.2 The digital economy

The digital economy is the global network of economic activity that is enabled by information and communication technology. It is constantly evolving, offering a vast number of opportunities for innovation. In addition, it has the potential to improve access to services, such as education, and to improve environmental, health and social outcomes in rural and regional areas.

Shopping

Perhaps one of the biggest uses of new technology is the aid to shopping. Online shopping has been present for much of the internet's existence. As technology has improved many more businesses are ensuring that they have an online presences and the customers can have access to products 24 hours a day, seven days a week anywhere in the world (see figure 3).

FIGURE 3 Online shopping at Christmas time



Opportunities of new services

- **Business.** Using applications and services that rely on the internet has improved efficiencies and reduced costs. For instance, an online business owner does not need to lease a premises, which is a big saving. This has resulted in an expansion of markets, through greater interconnections in Australia and overseas. Businesses will have more choice of location, particularly in rural and remote places. It can also improve efficiency, and may reduce the need for a physical presence, for example clothes retailers who can sell their t-shirts online without the need for a shop.
  Improvements in infrastructure will lead to improved technologies, such as videoconferencing, allowing healthcare, for example, to reach remote areas and promote the sharing of knowledge.
- **Education.** Distance between student and teacher will no longer prevent access to specialist teachers across Australia and the world. It will improve collaborative learning practices between schools and higher education facilities, and promote the international exchange of ideas. In addition, ICT has improved access to online learning and collaboration beyond the walls of the classroom.
- **Environment.** Access to digital technology has demanded new ways of managing household consumption of resources. Smart energy grids can be installed to manage energy consumption, and changes can be made during peak energy demands. Farming systems can be improved by technologies that are accessible with the improved ICT, such as measuring soil moisture in relation to weather conditions.

ACTIVITIES

IDENTIFY

1 Define the term *digital divide* in your own words.
2 What are the reasons for the digital divide?
3 Refer to figures 1 and 2 and with the use of a world map identify a country in each the following categories: 30–39, 50–59 and 80–89 internet users per 100 people.

EXPLAIN

4 Why is there a greater demand for data than there was 10 years ago?
5 Refer to figure 3; why are there more visits occurring on Boxing Day?

APPLY

6 Create a table showing the differences for a day and a week in the number of purchases you conducted via technology versus face to face. What do you think the split will be? Do your results surprise you?

18.9 ICT and increased connection to people

18.9.1 Death of distance

When many of your parents and grandparents were at school they would have had a pen friend. This was another person, usually of a similar age, who lived on the other side of the state, country or even the world. Letters would be handwritten and posted, and could take weeks to arrive. Today, you can get in touch with people anywhere in the world with the click of a button.

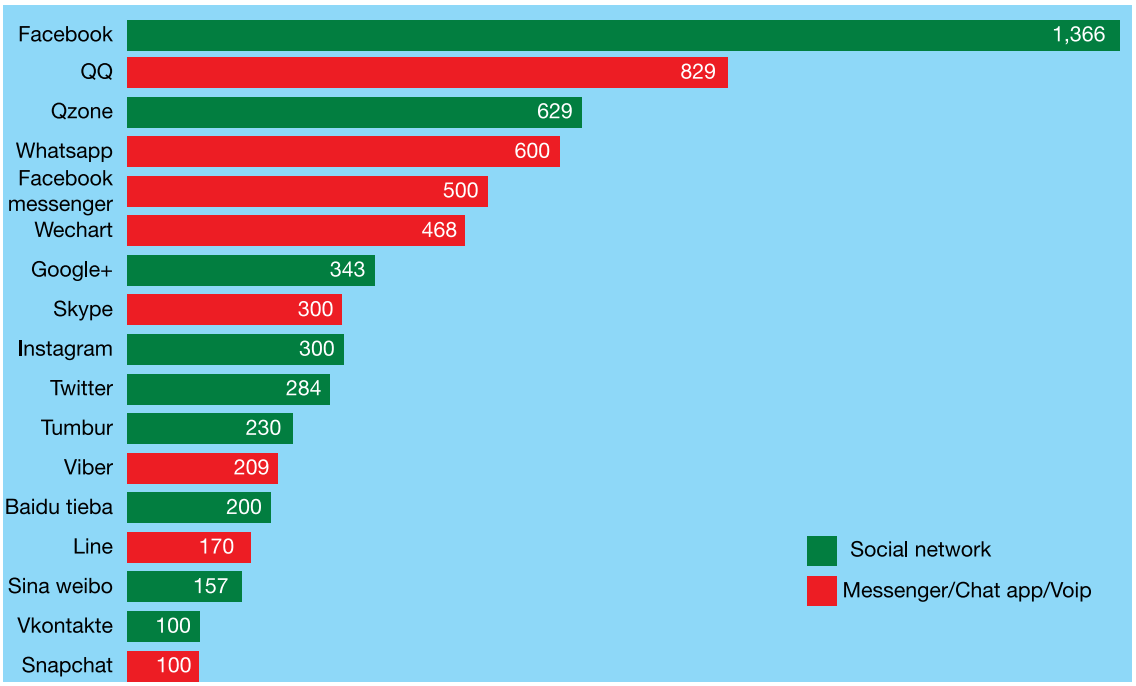
The term 'Death of distance' was coined at the end of last century and was used to explain how distance was no longer a limiting factor in people's ability to communicate.

> 'All distances in time and space are shrinking. Man now reaches overnight places which formerly took weeks and months of travel.'
>
> ***Source:*** German philosopher Martin Heidegger (1971).

18.9.2 Social media

Social networking sites were originally set up as a means of connecting people. Today, apps, such as Twitter, Instagram and Snapchat, allow people to connect and follow each other through text, photos and videos.

FIGURE 1 Most popular social media platforms



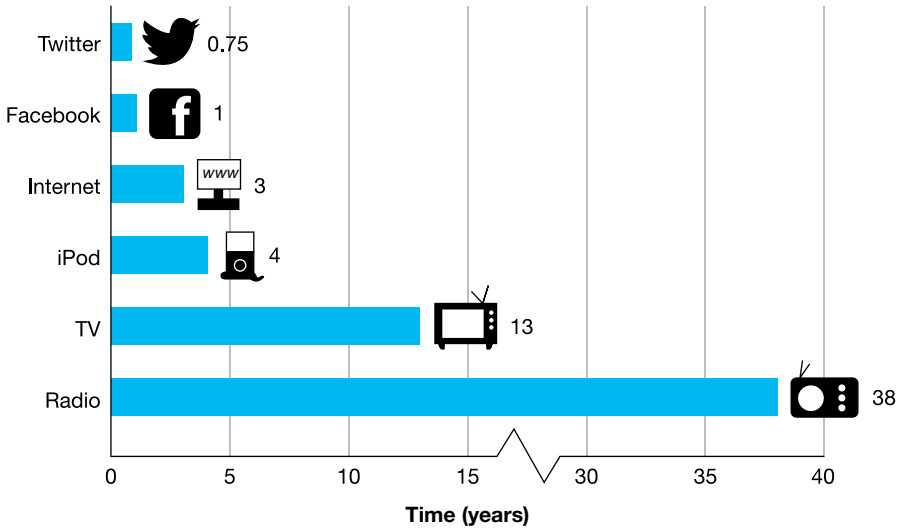
Every day there are over 1000 apps being submitted to the Apple app store. This means the ways in which we can connect to each other are evolving. Facebook was one of the first major social media websites and is still the most popular with over 1 366 000 000 users worldwide. Figure 1 shows the most popular sites worldwide. The rate at which people are adopting new technology is increasing, as is the speed of the connections. This is due to a range of factors including access, price and popularity. Figure 2 shows a comparison between the time taken for 50 million users worldwide to adopt different types of media.

18.9.3 Generations

Who uses the internet and social media, and how? The generation you belong to will affect the technology you choose to use. A 14-year-old is part of **Generation Z** and, unlike all

Generation Z those born after Generation Y, between 1995 and 2009

FIGURE 2 Time taken to reach 50 million users for different media



generations before them, they have never lived in a world without the internet. This varies greatly from their parents, **Generation X** and grandparents, the **Baby Boomers**. Along with **Generation Y**, who are those people aged 20 years and over, we can see how different platforms and apps appeal to different users (see table 1).

18.9.4 Trolls

One issue that can arise from these new technologies and forms of communications surrounds the issue of **anonymity**. Because communication is done online, rather than face to face, often people will type or post information and comments that they wouldn't say directly to a person. Internet trolls are people who deliberately intend to upset others by posting harmful or distressing messages. Sometimes they can set up accounts pretending to be someone else by using their name or identity. This can happen to celebrities and high-profile individuals but can also happen to anybody. These actions can often have extremely serious consequences.

Generation X those born after the baby boom, roughly between 1964 and 1980

Baby Boomers generally refers to those born during the post–World War II baby boom (1946–1964)

Generation Y those born after Generation X, between 1981 and 1994

anonymity where a person's details, such as their name, are unknown

TABLE 1 Demographics of different social media usage

Social networking sites used	Age (years)				
	18–29	30–39	40–49	50–64	65+
Facebook	97%	93%	95%	87%	88%
LinkedIn	23%	34%	29%	33%	12%
Instagram	54%	21%	17%	12%	2%
Google+	20%	29%	27%	20%	16%
Twitter	20%	28%	16%	10%	4%
Pinterest	22%	18%	18%	14%	8%
Snapchat	38%	7%	9%	3%	–
Tumblr	14%	2%	2%	4%	–

Source: https://www.sensis.com.au/assets/PDFdirectory/Sensis_Social_Media_Report_2015.pdf

FIGURE 3 A 'troll' is someone who deliberately, and usually anonymously, provokes arguments and upsets others online.



FOCUS ON FIELDWORK

Technology

Secondary data

We know that primary data is information that has been collected by you, whereas secondary data is that information that has been collected and interpreted by somebody else. The benefits of secondary data are that most of the work has already been completed with the questioning and collection of data already done. Copy and complete the table on the right regarding possible sources of secondary data and what may be positive and/or negative points for using the data.

Source of data	Positives	Negatives
e.g. Wikipedia	• Easy to access • Often contains current information	• Authors are unknown • Can be changed by anyone • Potentially unreliable

ACTIVITIES

IDENTIFY

1 How much longer did it take radio to get 50 million users than it took the internet?

APPLY

2 Why do you think that Twitter and Facebook managed to get so many users so quickly?

PREDICT

3 What do you think will be the next form of communication between people?

EXPLAIN

4 How many of the top 17 social platforms (see figure 1) do you use?

5 Have you heard of, or do you use, QQ? Why is this more popular than Twitter and Whatsapp combined?

6 What are your favourite apps? How do these differ from your parents' or teachers' favourite apps? Refer to figure 2.

7 Explain the differences in the popularity of some sites and apps between age groups.

8 What point do you think the cartoon in figure 3 is trying to make? Why is it likely to work?

18.10 Impacts of global connectivity on people and places

18.10.1 Connectivity

Global connectivity has been increasing rapidly over the past three decades. Many countries are in a race to develop their digital economies as they fear being left behind. We are moving towards a world in which personal mobile phone technology can connect every human being in every village in every country to knowledge, markets, services and communities.

This increased connectivity has affected people from villages and cities in all parts of the world in a range of ways, as well as having an impact on the natural environment (see figure 1).

FIGURE 1 Mobile phone use is increasing rapidly in Africa.



18.10.2 Positive impacts

Economic

The Global Connectivity Index (GCI) can be used to measure and predict a country's economic health. There is a strong link between GCI and a country's gross domestic product (GDP) — the higher a nation's GCI the higher the GDP. A 20 per cent increase in ICT investment will grow GDP by 1 per cent. Singapore has implemented a Smart Nation strategy, aimed at moving from natural resources and developing technological services. Greater connectivity and more integrated markets allow for new jobs and careers all over the world.

Social

The development of many countries can be enhanced with greater connectivity. A country's level of connectivity can be categorised using the terms *Leaders*, *Followers* or *Beginners*. By investing in older technologies such as 3G and mobiles, countries such as those in Africa and South America can enhance their levels of development much more rapidly, and therefore improve the standards of living for their citizens. It also allows for more connection between people from different cultures and backgrounds and hopefully greater understanding.

Environment

The climate change conference in Paris in 2015 (see figure 2) showed the benefits which can be achieved by an inclusive and connected approach to the environment. These talks involved **delegates** from 196 countries and culminated in the adoption of the United Nations resolution 'Transforming our world: the 2030 Agenda for Sustainable Development'.

delegate person sent or authorised to represent others, in particular an elected representative sent to a conference

FIGURE 2 The Eiffel Tower during the Paris Climate Change Conference



FIGURE 3 Some impacts of Western culture



18.10.3 Negative impacts

Economic

Poorer nations, or those unable to adapt to technological change as fast as other countries, may find themselves at a disadvantage. Whilst implementing new technology and infrastructure is important, if countries invest in the wrong areas they may have systems that become outdated or unable to handle the growing demands of its citizens.

Social

There is a risk of creating the 'haves' and 'have nots'. Those countries that are unable to keep pace with the Leaders may fall behind. Countries such as Portugal, Italy, Greece and Spain (the PIGS) are regarded as developed nations. However, they are now Followers when it comes to ICT. Beginner nations, such as those in Africa, are well behind the Leaders and will continue to remain there. There is also the possibility of 'westernisation' and loss of cultural identity.

Environment

With a greater push for ICT resources and infrastructure there will be continued pressure on the natural environment. The need for certain resources, such as copper, gold and nickel, will require continued mining and disruption to the natural landscape. The disposal and treatment of existing and outdated equipment is also an issue that needs addressing. E-waste is a growing global concern. However, many individuals, groups and governments have put in place plans to deal with this, such as Planet Ark which runs e-waste collection points at schools and nominated businesses.

FIGURE 4 e-waste



ACTIVITIES

IDENTIFY

1 What are considered older technologies?
2 Who invests in these technologies and why?

EXPLAIN

3 Why is there a link between GCI and GDP?
4 Why might Singapore have a greater need to develop 'digital fuel' rather than natural resources?
5 Refer to figure 3. What are the negative impacts that are portrayed in this cartoon?

INVESTIGATE

6 Use the internet to research some global campaigns that have support from people in many countries. What is the cause? Who is involved? How successful are they at achieving their aims? You could present your findings as a table or a poster.

APPLY

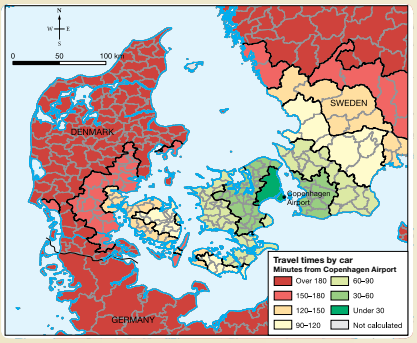
7 How much e-waste do you and your family produce in a year? How is old waste disposed of and could it be treated in a more environmentally friendly way?

eBook*plus*
ONLINE ONLY

18.11 SkillBuilder: Constructing and describing isoline maps

What is an isoline map?

An isoline map shows lines that join all the places with the same value. Isoline maps show gradual change in one type of data over a continuous area. Isolines show change in the trend of the data being mapped. Isoline maps are easy to understand, especially when coloured between the lines



eLesson

Watch this video to learn how to construct and describe an isoline map.



Searchlight ID: eles-1737

Interactivity

Try this interactivity to learn how to construct and describe an isoline map.



Searchlight ID: int-3355

18.12 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

18.6 SkillBuilder: Interpreting topological maps

18.6.1 Tell me

What is a topological map?

Topological maps are very simple maps, with only the most vital information included. These maps generally:

- use pictures to identify places
- are not drawn to scale
- give no sense of distance
- give general directions
- exaggerate the size of places
- do not show exact routes.

However, everything is correct in its interconnection to other points.

Why is a topological map useful?

Topological maps are useful as a mental map to help you locate important features. Large areas can be drawn to show the viewer the important points. You could use these in class as summary maps of a topic, or as quick sketch maps to illustrate a point or to clarify something for another student.

They are also useful for:

- giving tourists a snapshot of where features are located
- quickly showing how to get to a place
- showing very large transport routes such as bus and train routes across a city
- planning international flights.

Model

The topological map of central Paris shown in figure 1 is designed for people moving around Paris as tourists. It provides an indication of the major sites that tourists ought to visit, and allows them to see on which side of the river different monuments are found. For example, you would expect to find the Champs-Élysées and the Louvre on the same side of the river and quite close to each other. Major routes are given between monuments but these routes may not be the shortest distance, as there is no scale with the map. Thus, it is hard to judge the best way to get from the Eiffel Tower to Notre Dame cathedral. The actual direction from one monument to the other is unlikely to be exact, because the lack of scale causes features to become distorted. This type of map, however, might help a tourist plan their sightseeing, because it gives the user a general idea of where things are located. If going from the Eiffel Tower to the Arc de Triomphe, is it best to stroll along the river and up a major route?

A good interpretation of a topological map:

- identifies and communicates key features
- clearly represents and communicates the data.

FIGURE 1 A tourist map of Paris and its monuments



eBook*plus*

eLesson
Interpreting topological maps
Searchlight ID: eles-1736

18.6.2 Show me

How to use a topological map

You will need:

- a topological map.

Procedure:

STEP 1

Look all around the topological map and identify the key features being shown. In figure 1, almost 30 major tourist attractions of Paris are shown as drawings of each place. Some drawings are larger than others to show the significance and the popularity of these places with tourists.

STEP 2

Think about the interconnection between features. On the map in figure 1, the interconnection between the places is that each one is a Paris tourist attraction. Roads are shown, but these may not be the optimum route to travel. This pathway represents just one way to connect between the places.

eBook*plus*

Interactivity
Interpreting topological maps
Searchlight ID: int-3354

STEP 3

Since there is no scale, could a tourist walk between all these places? Think about possible distances. Consider the distance from the airport to the city centre. A tourist may well have travelled this route and be able to give the map a sense of scale. Could you see all these monuments in a day? The answer to both questions is no. Interpreting a topological map gives a first impression, but it is not an accurate map. It may be useful for moving around an area, but it lacks detail.

18.6.3 Let me do it

Developing my skills

Using the child's map shown below, describe the route the child takes from home to school.

FIGURE 2 Drawing by a child who walks to school



Questions

1. What is the purpose of this topological map?
2. Describe the pattern of houses along the route.
3. What symbols have been used to show the sporting area of the school grounds?
4. Why do you think this child drew the road at such a size and included the road markings?
5. Describe the environment along the route from home to school.

Checklist

I have:

- identified and communicated key features on the topological map
- clearly represented and communicated the information in the description.

Skills questions

1. Topological maps are used to show:
   a. the location of features of a place
   b. the distance between places
   c. the contours of an area
   d. very small areas.
2. A topological map includes information about:
   a. scale
   b. distance
   c. the interconnection of places
   d. realistic impressions.
3. Why are topological maps not accurate?
4. What important map information is not provided on a topological map?

18.11 SkillBuilder: Constructing and describing isoline maps

18.11.1 Tell me

What is an isoline map?

An isoline map shows lines that join all the places with the same value. Isoline maps show gradual change in one type of data over a continuous area (see figure 1). Isolines do not cross or touch each other. Isolines show change in the trend of the data being mapped. The same difference is always shown between each isoline and the next over the entire map.

Why is an isoline map useful?

Isoline maps are easy to understand, especially when coloured between the lines (see figure 2). These maps do not consider boundaries or borders, as the lines connect all places of the same value. Trends and gradual changes are easily identified. Some isoline maps can show change over time. Excellent examples of isoline maps include daily weather maps (showing places with the same atmospheric pressure), topographic maps with contour lines, and global isotherm maps (places of equal mean surface temperature are connected; such maps are used when discussing climate change).

They are also useful for:

- showing data over large areas
- showing trends in data
- allowing you to identify and describe patterns
- comparing maps over different time periods.

Model

FIGURE 1 An isoline map showing places of equal travel time to Copenhagen airport by car



Source: Spatial Vision

The isoline maps in figures 1 and 2 show that it takes less than 30 minutes of travel time by car to reach Copenhagen airport in Denmark from places closest to the airport, even when it is on a different island or in a different country (Sweden). People living west of central Copenhagen travel similar distances to the airport in similar times (60–90 minutes) to those living in southern Sweden. This suggests that connections such as bridges and tunnels between islands and countries are provided, and cross-border movement is easy. From one island it takes 150–180 minutes to get to the airport, suggesting that a ferry service is probably required to reach the road system by car.

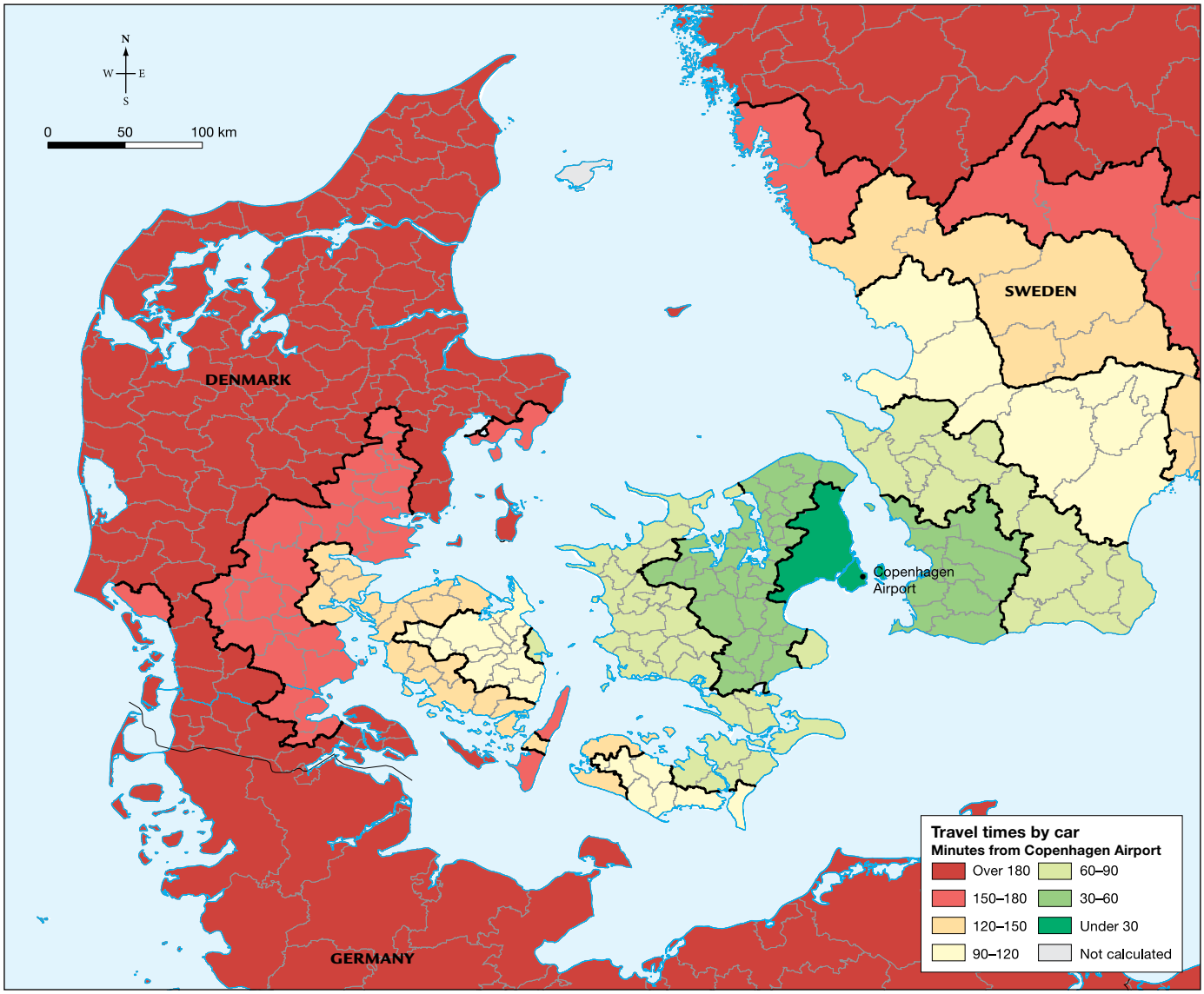
A good isoline map:

- has small dots for data presentation
- has dots joined with a fine line
- is drawn with pencil
- is coloured or shaded between the isolines
- uses BOLTSS.

A good description of an isoline map:

- identifies and communicates key features
- clearly represents and communicates the data.

FIGURE 2 A coloured isoline map showing travel time to Copenhagen airport by car



Source: Spatial Vision

18.11.2 Show me

How to construct and describe an isoline map

You will need:

- a base map
- a set of data to plot
- a pencil
- an eraser
- an atlas (optional).

eBook*plus*

eLesson
Constructing and describing isoline maps
Searchlight ID: eles-1737

Procedure:

Constructing an isoline map

STEP 1

Select a set of data to map, and plot the relevant figure at each of the places listed. Figure 1 is an example of this for travel times by car to Copenhagen airport.

STEP 2

Select a value to use for intervals within the data set. In figure 1, the interval was set at 30 minutes. Draw lines (isolines) joining places of the same value; in this example, that would be 30 minutes, 60 minutes, 90 minutes and so on. You may need to go between some points to show where you think the isoline would be; for example, the 60 minute isoline would pass between a place where

the travel time is 50 minutes and another where the travel time is 70 minutes. Remember that isolines will not touch and will not cross at any point.

STEP 3

Create a legend for your map with a colour system that indicates a gradation of colour, where the lowest data is the lightest shade and the highest data is the darkest. Shade between the isolines according to the legend. Figure 2 shows a completed coloured isoline map.

STEP 4

Don't forget to apply BOLTSS to your map.

Interpreting an isoline map

STEP 5

First, make sure you know what feature is being mapped by checking the map title or caption. In figure 1, this feature is travel time by car to Copenhagen airport.

STEP 6

Next, check the key/legend so that you understand the value of each isoline and the intervals used between them.

STEP 7

Describe the areas where there are high or low data values that help to form a pattern. You may need to refer to an atlas to check the topography and establish whether any country borders are involved. In figure 1, some of the data is from Sweden as people travel from there to Copenhagen, their nearest airport. People living west of central Copenhagen travel similar distances to the airport in similar times (60–90 minutes) to those living in southern Sweden.

STEP 8

Look for any anomalies that may need explaining. For example, in figure 1 you can see that it takes 150–180 minutes to get to the airport from one island, suggesting that a ferry service is probably required to reach the road system by car.

eBook*plus*

Interactivity
Constructing and describing isoline maps
Searchlight ID: int-3355

18.11.3 Let me do it

Developing my skills

Use the base map provided in figure 3 and the data in table 1 to construct an isoline map of the travel times by bicycle throughout Copenhagen to the city centre. Use the following steps to help you.

a. Plot on the map the number of minutes taken to travel from each place to Copenhagen city centre by writing the number of minutes by the dot beside each place name.
b. Draw a line (an isoline) connecting all the places from which it would take 30 minutes to travel to the centre of Copenhagen.
c. Draw additional isolines at 5-minute intervals to show travel times to Copenhagen city centre. Describe the pattern evident on your isoline map.

TABLE 1 Travel times by bicycle across Copenhagen

Suburb of Copenhagen	Travel time by bicycle to Copenhagen city centre
Albertslund	45
Ballerup	48
Brøndby	40
Frederiksberg	25
Furesø	50
Gentofte	33
Glostrup	40
Gladsaxe	38
Herlev	42
Hvidovre	34
Ishøj	55
Lyngby–Taarbæk	45
Rødovre	35
Tårnby	30

FIGURE 3 A base map of the suburbs around Copenhagen city centre



Source: Spatial Vision

Questions

1. Is Furesø or Hvidovre more accessible to Copenhagen city centre by bicycle? Use figures in your answer.
2. Does Tårnby or Brøndby provide easier bicycle access to the city? Quote the distances involved.
3. From which direction would you have the greatest level of access to the city centre by bicycle? Use figures in your answer.
4. Which part of the map would encourage cyclists to live in the area? Explain your answer using figures.
5. In which area of the city would you prefer to live if you had to cycle to the city centre each day for work? Explain your answer, including figures.

Checklist

In drawing an isoline map I have:

- plotted data using small dots
- joined the dots to create a fine isoline
- drawn using pencil
- coloured or shaded between the isolines
- completed my map with BOLTSS.

In describing an isoline map I have:

- identified and communicated key features
- clearly represented and communicated the data.

Skills questions

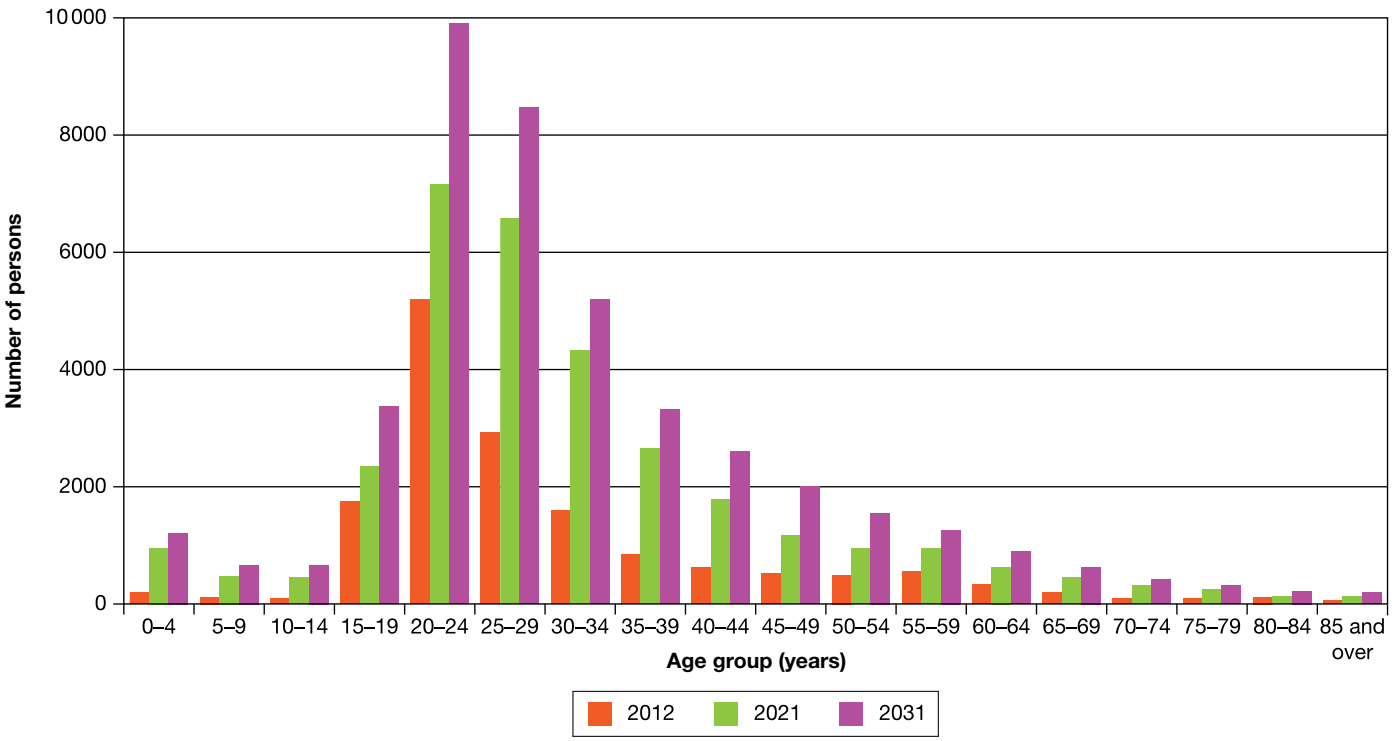
1. Isoline maps are used to:
   a. locate features of a place
   b. show the varied features of a place
   c. join places with the same or equal value
   d. indicate a key feature of a place.
2. An isoline map includes information about:
   a. trends in the values mapped
   b. two or more features of an area
   c. data at only one place
   d. very few data points.
3. Why are isoline maps useful when maps cover large areas?
4. What makes an isoline map easy to read?

18.12 Review

18.12.1 Review

1. What forms of transport have experienced the most significant changes? Refer to subtopic 18.2.
2. What have been the improvements made to aircraft in the last 50 years?
3. Refer to table 1 in subtopic 18.2.
   a. Which nation has the most ports on the top 10 list?
   b. Why do you think this is the case?
4. Refer to figure 1.
   a. How is the population of Melbourne's CBD going to ***change*** over the next 10 or so years?
   b. Which age groups will make up most of Melbourne's resident population in 2031? Why do you think this will be the case?

FIGURE 1 Forecast age structure, Melbourne CBD



Source: This information resource is delivered and maintained by .id, specialists in demographic and economic profiling and forecasting. Copyright © .id2013.

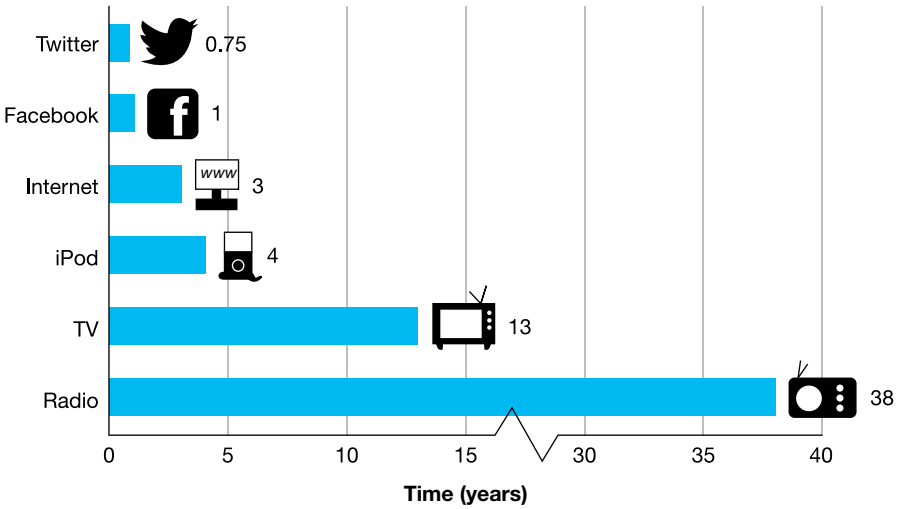
5. Create a survey on the use of public transport in your community. As a class, conduct a survey of your family and friends (finding ten survey respondents each) about their reasons for using or not using public transport. As a group, and with the guidance of your teacher, design a manageable set of eight to ten questions that can be answered before your next lesson. As a starting point, find out who uses public transport, and why and how they do so. Compile your data on the board, and then individually create tables, graphs or pie charts to demonstrate the results of each question. Conclude your report with a discussion on what your data tells you about the reasons for public transport use in your community. How might you encourage more people to use public transport?
6. What types of disabilities would make it most difficult to travel on public transport? Why?
7. What types of disabilities would make it most difficult to move or navigate through city streets? Why?
8. Define *web 1.0, 2.0.* and *3.0.*

9. Describe the trend of internet and mobile phone use in Australia.
10. Explain the geographical pattern of internet use around the world.
11. What are the main types of social media platforms used by different generations?

18.12.2 Reflect

12. What impact will advancements in technology have for people in developing countries?
13. Who will benefit most from advances in global connectivity and why?
14. Refer to figure 2. Suggest reasons for the time periods for each of the various mediums to reach 50 million people.
15. Compare the positive impacts to the negative impacts of global connectivity. How do you think this will change in the future?

FIGURE 2 Time for various media to reach 50 million users worldwide (in years)





Container terminals, Hong Kong, China

CHAPTER 19

Buy, swap, sell and give

19.1 Overview

19.1.1 Introduction

Trade, in the form of buying, swapping, selling and giving goods and services, is a driving force that interconnects people and places all over the world. Trade has gone on ever since human societies existed. In contrast, international aid is a modern phenomenon, although countries have always had internal programs to help those in need. Trade and aid can bring people together to share the Earth's resources, but there can be problems when those resources are limited and, potentially, have negative consequences for the environment. The big question is how to organise trade and aid so that it fosters social justice and is fair and sustainable.

Starter questions

1. What goods and services do you need to support your lifestyle? Think about your everyday life at home, at school, and in sport, recreation and hobbies.
2. Where do you access your goods and services? To what extent do you obtain goods and services online?
3. From what you know, do you think all trade that occurs in the world today is fair? How can fair trade and aid make the world a better ***place*** for all?

Inquiry sequence

		Syllabus outcomes
19.1 Overview		
19.2 How does trade connect us?		GE4-4
19.3 **SkillBuilder:** Constructing and describing a flow map	eBook*plus* ONLINE ONLY	GE4-8
19.4 How does trade connect Australia with the world?		GE4-4
19.5 How is food traded around the world?		GE4-4
19.6 **SkillBuilder:** Constructing multiple line and cumulative line graphs	eBook*plus* ONLINE ONLY	GE4-7
19.7 How are markets and factories linked?		GE4-4, GE4-5
19.8 **Investigating topographic maps:** How is Singapore linked to other places?		GE4-4
19.9 How has international automotive trade changed?		GE4-2, GE4-3, GE4- 4
19.10 Are global players altering the industrial landscape?		GE4-2, GE4-3, GE4-4,
19.11 Why is fair trade important?		GE4-4, GE4-5
19.12 Why does Australia give foreign aid?		GE4-4, GE4-5
19.13 Why is the illegal wildlife trade a cause for concern?	eBook*plus* ONLINE ONLY	GE4-4, GE4-5
19.14 **Review**	eBook*plus* ONLINE ONLY	
Key terms	eBook*plus* ONLINE ONLY	



eBook*plus*

Watch this video
Trading places
Searchlight ID: eles-1724

19.2 How does trade connect us?

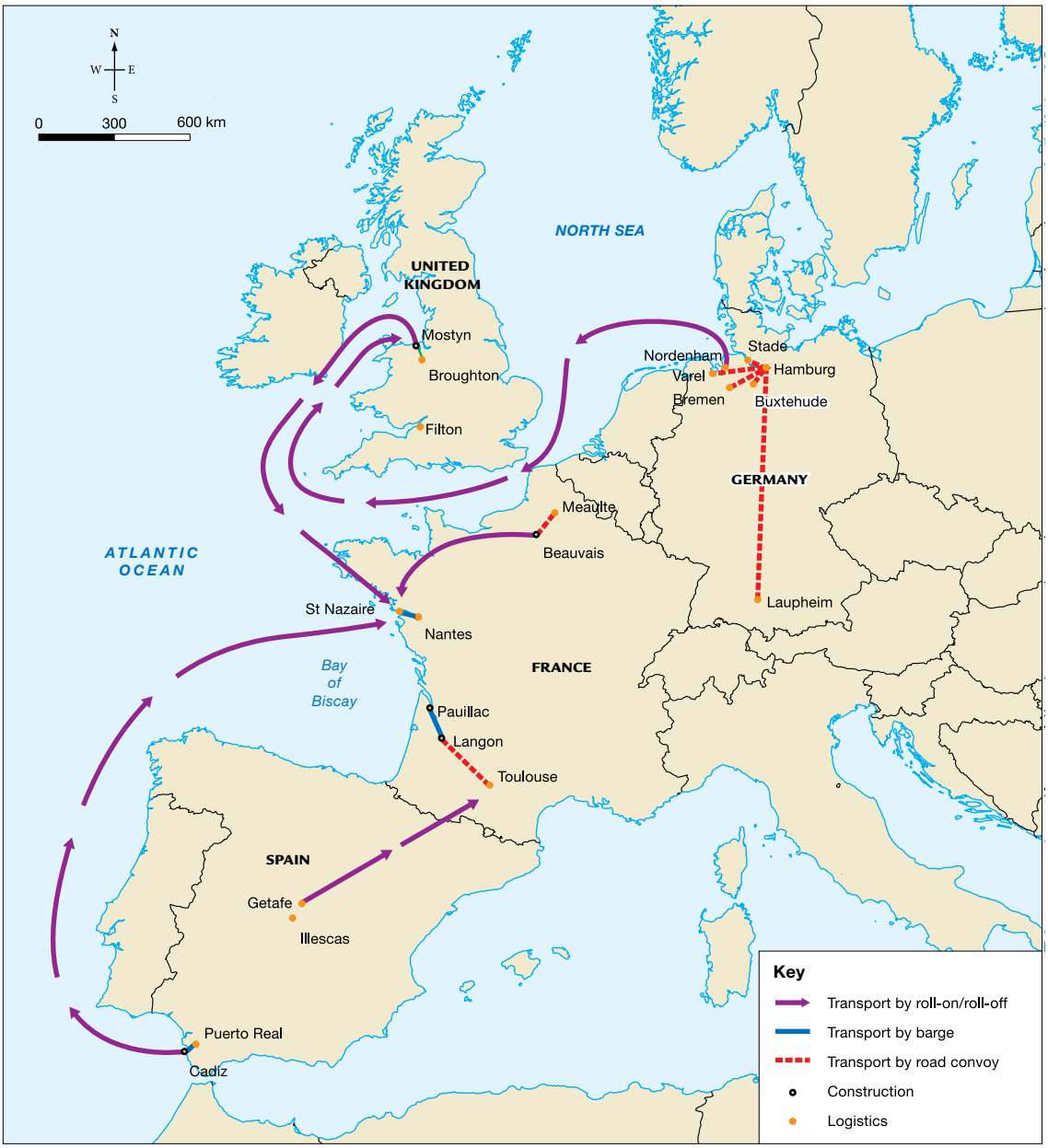
19.2.1 Trade in goods and services

eBook*plus*

Interactivity
Up, up and away
Use this interactivity to learn more about how the manufacturing of planes connects places.
Searchlight ID: int-3339

The system of trade has been around for a long time. Its earliest form was bartering at local markets. Merchants also used land and sea routes to access markets in foreign lands and exchanged goods for payment. Today we have a highly sophisticated, large-scale, global system of trade. A modern example of the interconnection of trade is the production of the Airbus A380. To construct this plane, component parts must be purchased from different countries and transported over land and sea to reach their final assembly place in Toulouse, France (see figure 1).

FIGURE 1 The component parts routes of the Airbus A380



Source: Data from Wikimedia Commons, User: Steff.

Trade connections in Australia

Throughout Australia and your local area, a system of trade and *interconnection* occurs. A visit to a local market will reveal a range of goods and services on offer from global, national, regional and local source areas, as shown in figures 2 and 3.

Goods and services, of which there are many, are generated by either processing Earth's resources or people doing things for each other. A good can be an item as simple as a loaf of bread or it can be as complex as a motor car. A service is not something you can hold in your hand; examples of services are education in a school or the advice a doctor gives a patient. What types of goods and services do you use to support your lifestyle?

As seen in figure 5, the processing of a resource into more complex goods can be a series of transitions, in which there is **value adding** at each level of industry (that is, its value increases). An important consideration in the production of goods and services is the impact on the environment.

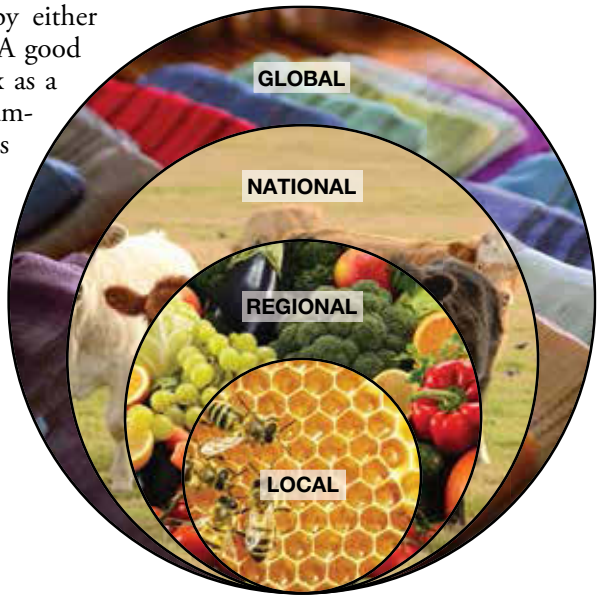


FIGURE 2 The scale of production found at a local market: global products (Fair Trade goods from Nepal); national products (beef and livestock from all states of Australia); regional products (fresh fruit and vegetables from the Hunter Valley); local products (honey from local bees)

value adding processing a material or product and thereby increasing its market value

FOCUS ON FIELDWORK

Fieldwork visit to a farmer's market

Aim

To investigate the interconnections between places and your local area

Task

Find out when and where markets, or the local show, take place in your town or suburb.

1 Investigate the source regions for the produce sold at the market. You can make a list of the locations by talking to the stall holders or taking photographs of the signs promoting the goods.
2 Are any of the products made using sustainable methods?
3 What are the advantages to customers from buying at this market?

On your return to school

4 List the produce that was local in origin; i.e. 0–50 kilometres away.
5 List the produce that was sourced from areas greater than 50 kilometres away from the market.
6 Select one product sold at the market that was sourced from a different environment. What is the environment like where this product comes from?

Farmers Market

- ✓ Where held?
- ✓ How often?

Observations

- ✓ Tally of produce for sale

Plants	Dairy	Fruit
IIII	I	IIIII III

- ✓ Source area of produce
- ✓ Customer numbers
- ✓ Photographs of:
  - Products being sold
  - Interesting scenes at the market

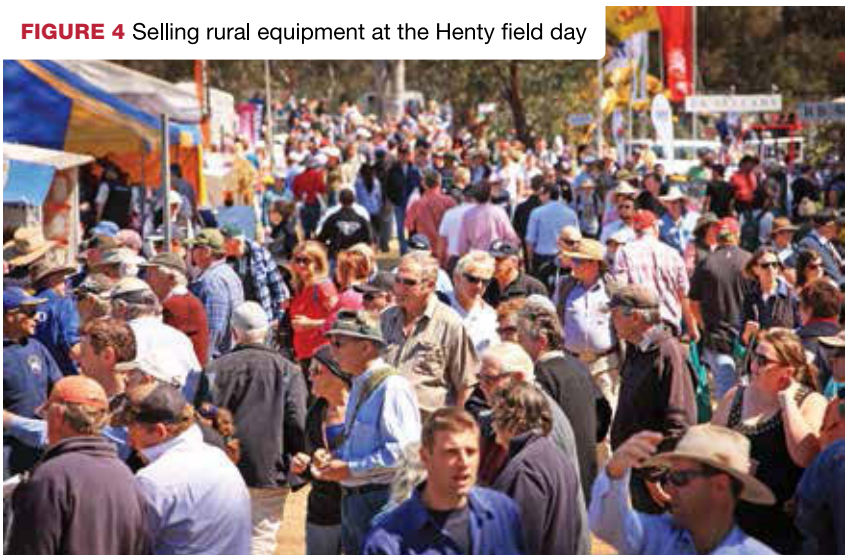
Interview

- ✓ Reason for seller attending this market
- ✓ Interesting points?

FIGURE 3 Regional produce at a city market



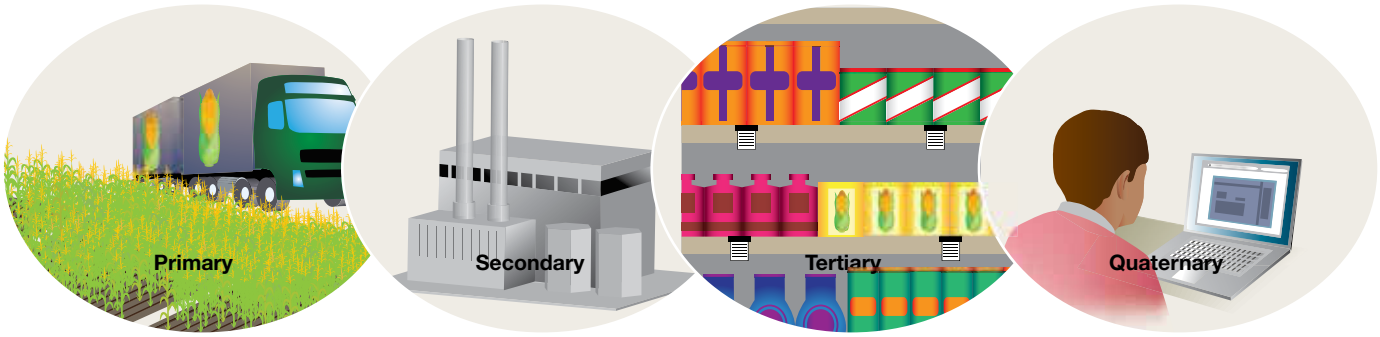
FIGURE 4 Selling rural equipment at the Henty field day



Interstate business

A heavy concentration of Australia's settlement in the south-east has led to a strong trade connection between major urban, regional and interstate places. Freight companies transport raw materials such as fresh agricultural produce (**primary industry**) to locations that process the raw materials into a more useful product (**secondary industry**). Manufactured goods are distributed to shops for sale (**tertiary industry**). Then the information that is gathered by companies is used for marketing purposes (**quaternary industry**).

FIGURE 5 Four levels of industry



primary industry the gathering of natural resources, such as iron ore and timber, or activities such as farming and fishing

secondary industry making raw materials into a more useful product; for example, making timber tables

tertiary industry selling goods and services; for example, a furniture business

quaternary industry gathering information about an industry; for example, marketing furniture

Freight is transported around Australia using rail, road, air and shipping. Major ports are used to link land-based (rail and road) and sea-based transport systems. Many global trade links are accessed through ports. When international shipping containers arrive in ports, they are transferred to road and rail transport for distribution within Australia.

FIGURE 6 Coal is a bulky product to transport.



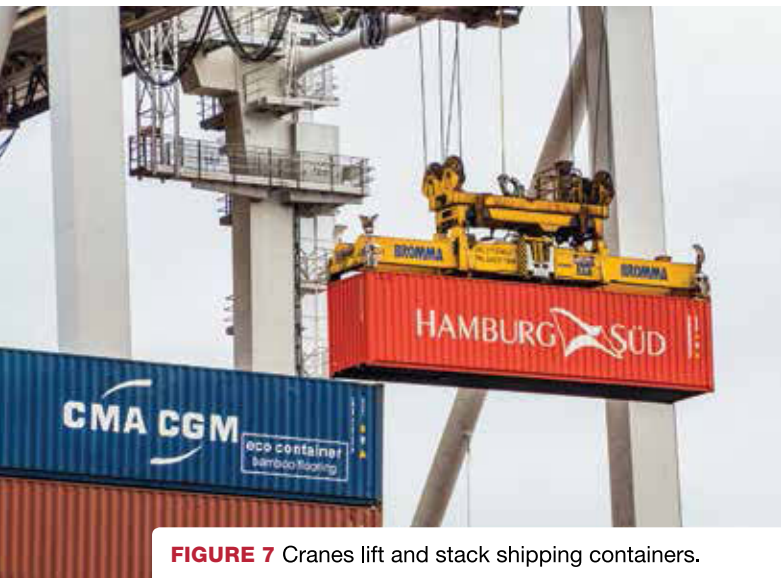


FIGURE 7 Cranes lift and stack shipping containers.



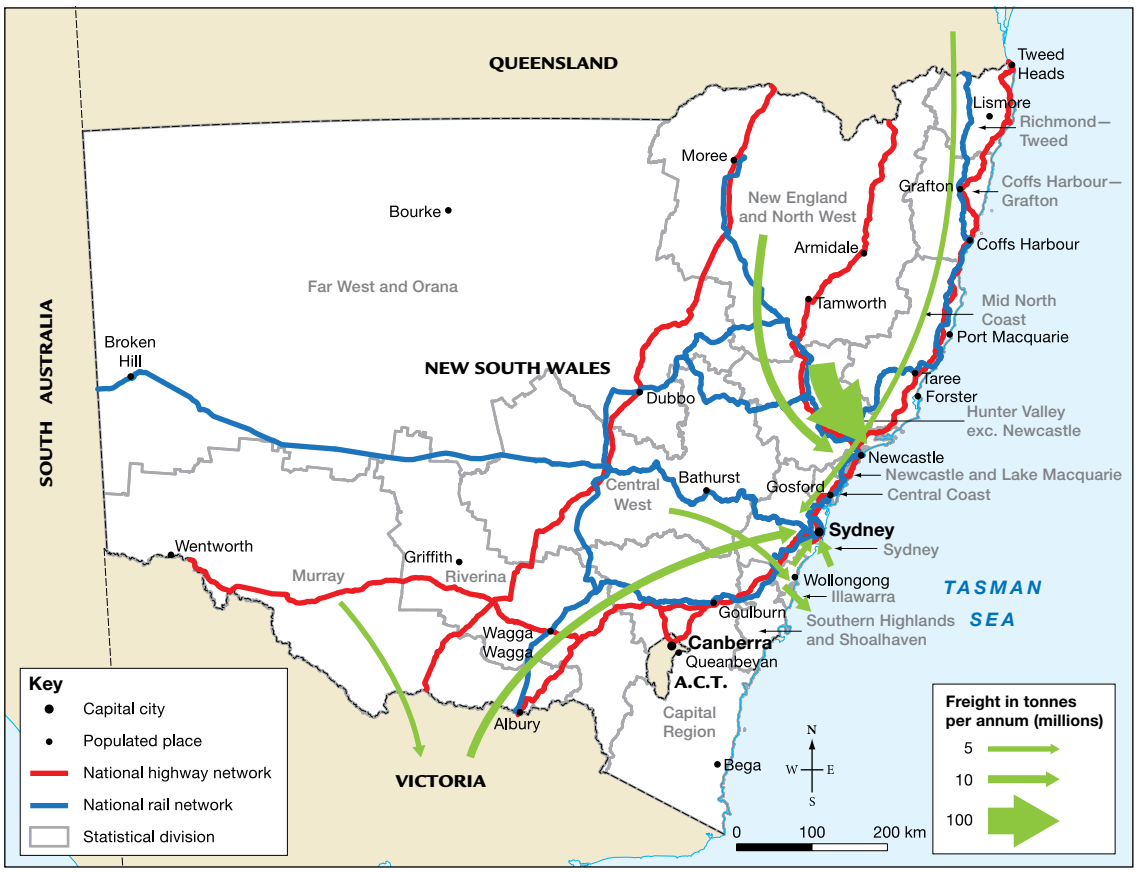
FIGURE 8 Road trains transport fuel.

GEOskills TOOLBOX

Flow maps

Flow maps show the movement and the volume of movement between places and environments. In figure 9, arrows indicate the direction of the freight flow between places. The arrow connecting the Hunter region and Newcastle is widest and indicates a large volume of traffic (100 million tonnes per year) between these two places. A flow map of student movements between school and each individual's home would reveal the locations that most students travel from and to each day.

FIGURE 9 Inter-regional freight flows for NSW during 2011



Source: Transport for New South Wales and Australian Bureau of Statistics.

ACTIVITIES

IDENTIFY

1 What reasons can you suggest as to why goods and services are traded?
2 Name the four levels of industry, and give an example of a good as it moves through the production process.

EXPLAIN

3 Suggest reasons why component parts of the Airbus A380 must come from different ***places*** (countries).
4 Explain what is meant by the term *value adding*, as a product moves through the four levels of industry. Choose a product such as wheat or timber.

APPLY

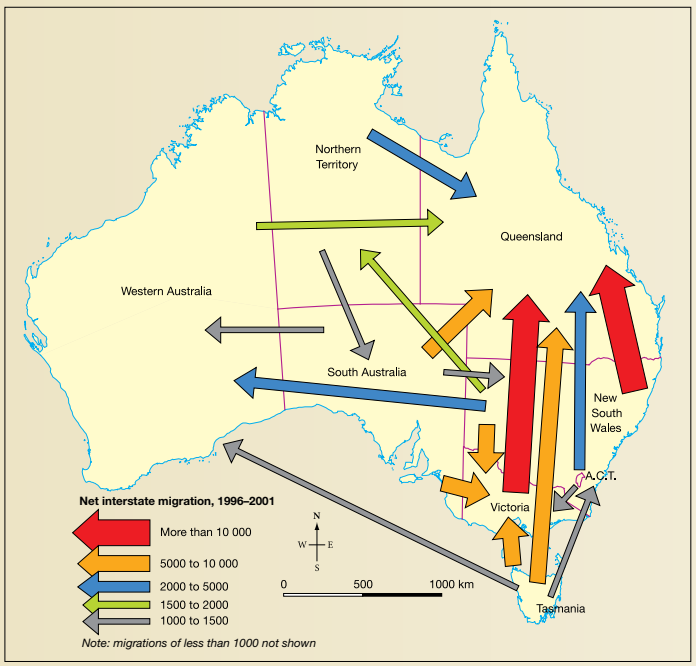
5 Suggest reasons customers are attracted to a local farmers market.
6 Prepare a poster to advertise a local farmers market and a farmers market at Port Moresby, in Papua New Guinea. What are the differences in the type of produce available?

eBook*plus* ONLINE ONLY

19.3 SkillBuilder: Constructing and describing a flow map

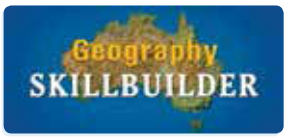
What is a flow map?

A flow map is a map that shows the movement of people or objects from one place to another. Arrows are drawn from the point of origin to the destination. Sometimes these lines are scaled to indicate how much of the feature is moving. Thicker lines show a larger amount; thinner lines show a smaller amount.



Source: MAPgraphics Pty Ltd, Brisane

eLesson
Watch this video to learn how to construct and describe a flow map.



Searchlight ID: eles-1741

Interactivity
Try this interactivity to learn how to construct and describe a flow map.



Searchlight ID: int-3359

19.4 How does trade connect Australia with the world?

19.4.1 Australia's trade organisation

Australia is one of the 164 members of the World Trade Organization (WTO), which covers 95 per cent of global trade. The organisation promotes free and fair trade between countries and, since 2001, its Doha Development Agenda has aimed to help the world's poor by slashing **trade barriers** such as tariffs, quotas and farm subsidies.

trade barriers government-imposed restriction (in the form of tariffs, quotas and subsidies) on the free international exchange of goods or services

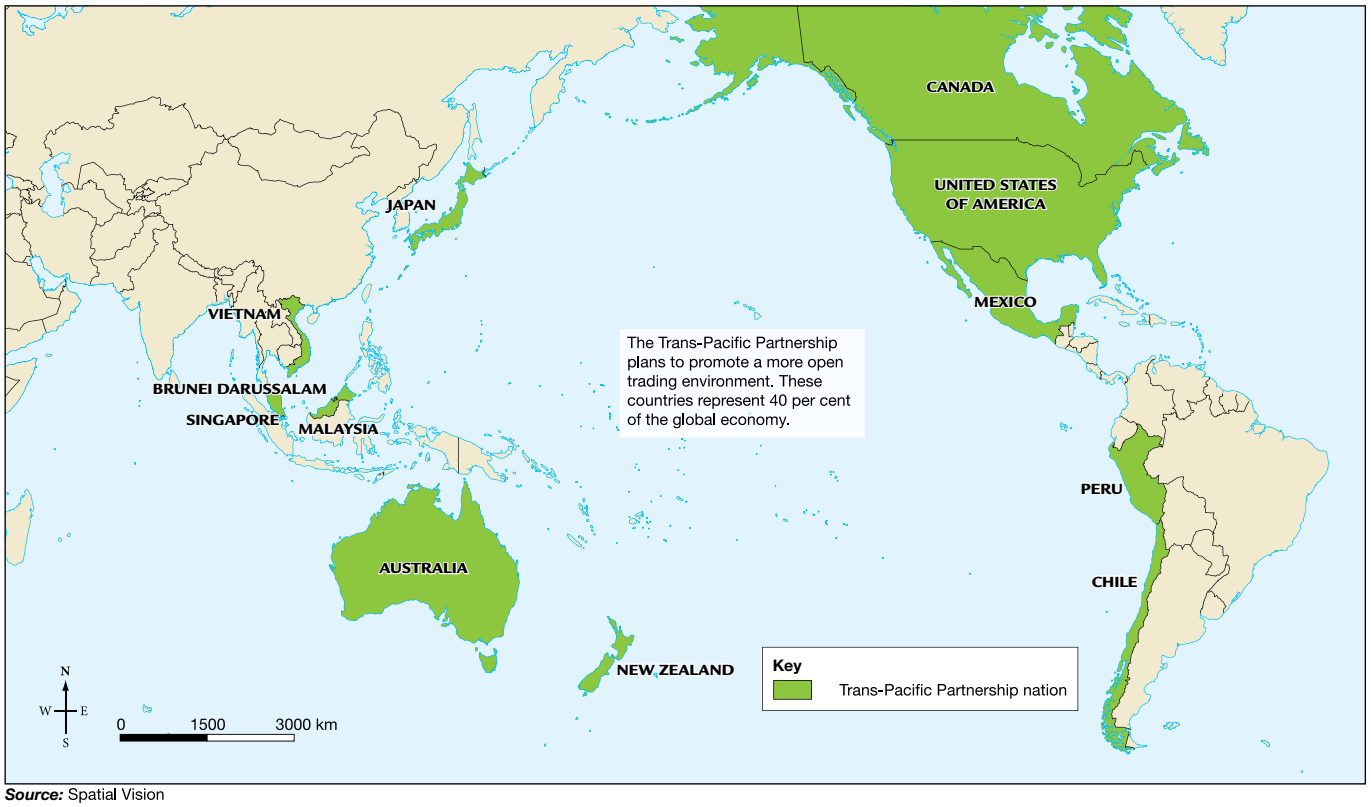
The Australian Department of Foreign Affairs and Trade (DFAT) coordinates trade agreements on behalf of the Australian Government, and the Australian Trade Commission (Austrade) promotes the export of goods and services. About 70 per cent of Australia's trade is with the member countries of the Asia–Pacific Economic Cooperation (APEC) forum.

FIGURE 1 People involved with trade



Free Trade Agreements have been negotiated by Australia with a number of countries in the Asia-Pacific region. The Trans Pacific Partnership (TPP) also creates opportunity for trade.

FIGURE 2 In 2016 the TPP was being negotiated by 12 nations.



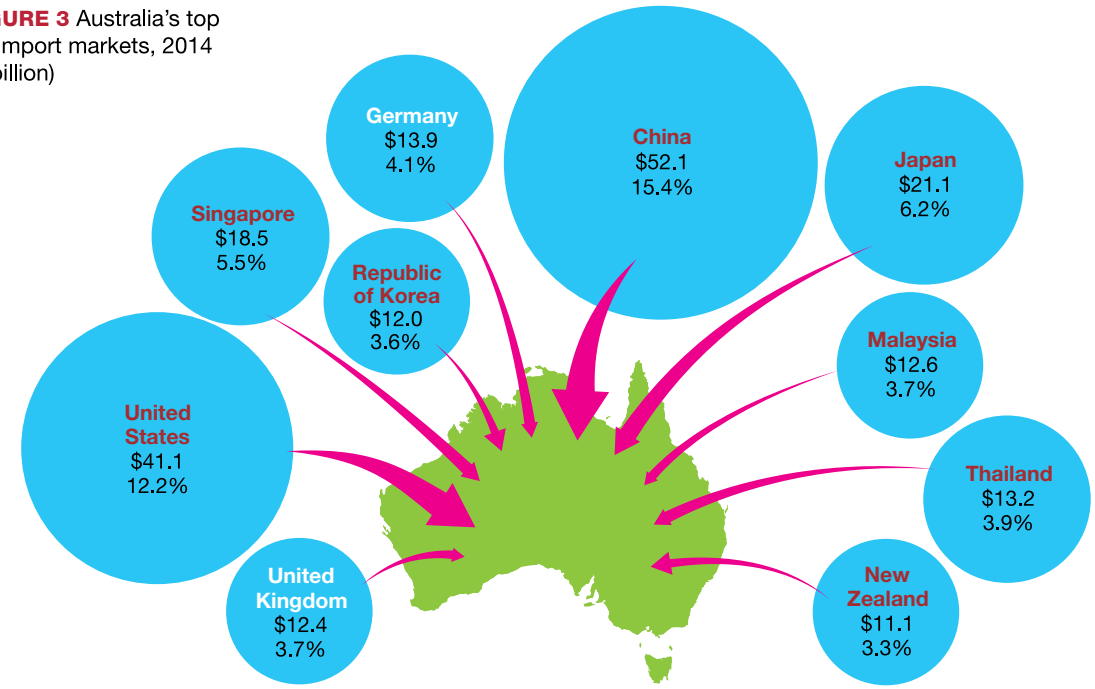
Source: Spatial Vision

19.4.2 Australia's trading partners

trading partner a participant, organisation or government body in a continuing trade relationship

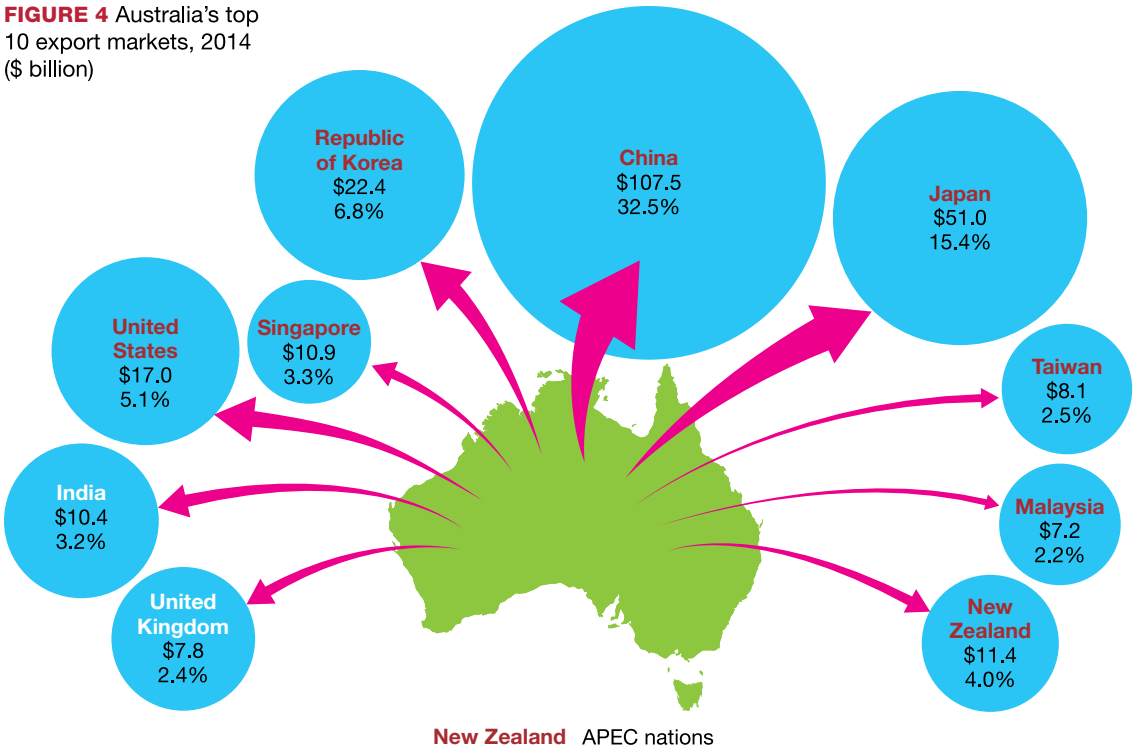
China, Japan and the United States were Australia's top three **trading partners** in 2014. Figures 3 and 4 show details of Australia's import and export trade.

FIGURE 3 Australia's top 10 import markets, 2014 ($ billion)



New Zealand APEC nations

FIGURE 4 Australia's top 10 export markets, 2014 ($ billion)



19.4.3 Australia's types of trade

Exports

Australia's export trade in 2014 was valued at $318 billion, and was dominated by the mineral products of iron ore, coal and petroleum. Recreational and educational travel, technical and other business services wereAustralia's leading services exports. Recent bilateral and multilateral trade agreements between Australia, the USA and a number of Asian economies have focused on removing tariffs on many products. These agreements will create new opportunity for strengthening demand in Australia's tourism, health services and agriculture into the future. However, the negative impacts of these agreements may include a loss of local jobs, loss of export income and a loss of control over product quality.

Imports

Like many countries, Australia is not self-sufficient in all goods and services. In 2014, Australia imported goods and services to a value of $338.6 million. Figure 6 shows the main aspects of this trade.

FIGURE 5 Australia's top 10 exports of goods and services, 2014–15 ($ million)

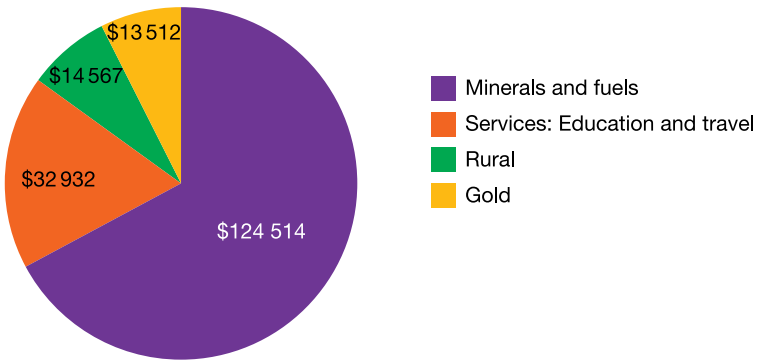
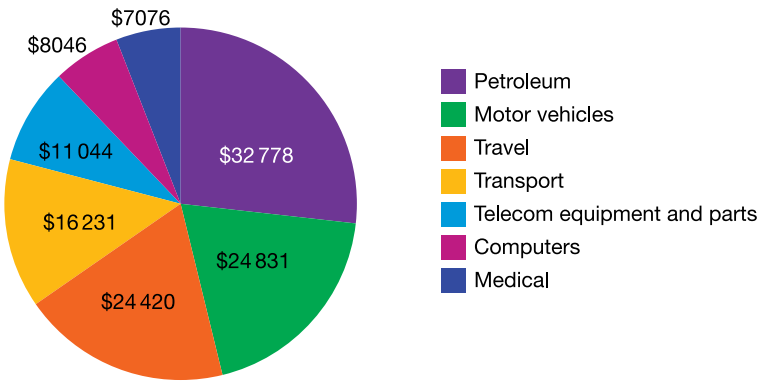


FIGURE 6 Australia's top 10 imports of goods and services, 2014–15 ($ million)



Regional trade opportunity

Australia's strategic location within the Asia–Pacific region has led to tourism, study and sport interconnections with our neighbours. In 2014, a category of 'educational travel services' was ranked our number three export and was valued at $15.7 billion. With 543123 international students studying in Australia, education is now very important for our economy. In effect, it is a service export, in that students are paying for knowledge that they will take back to their home country.

FIGURE 7
International students studying in Australia, 2015

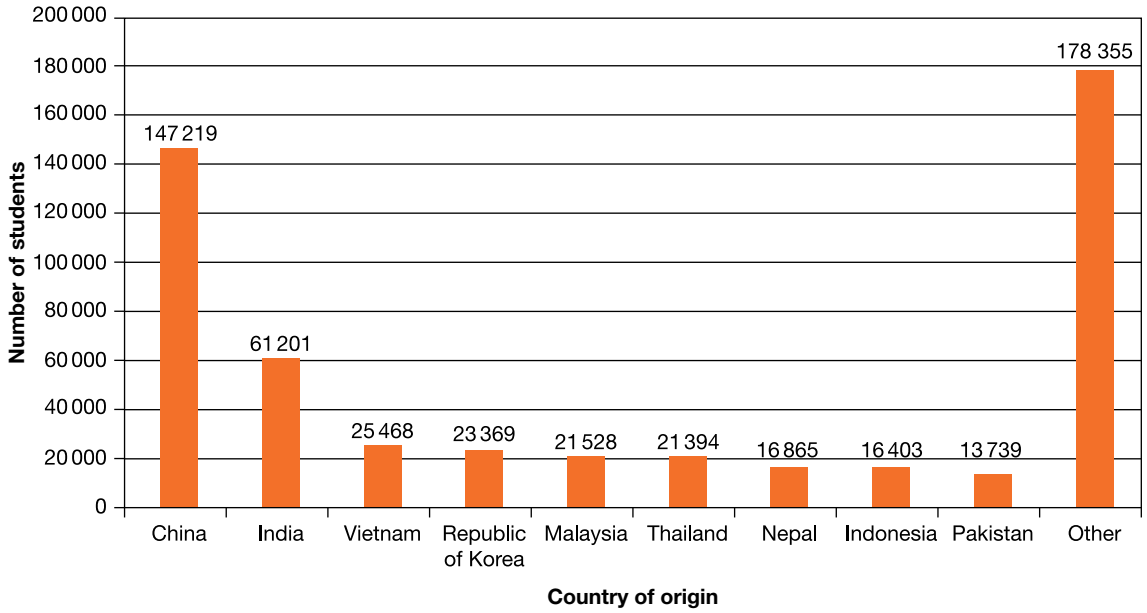
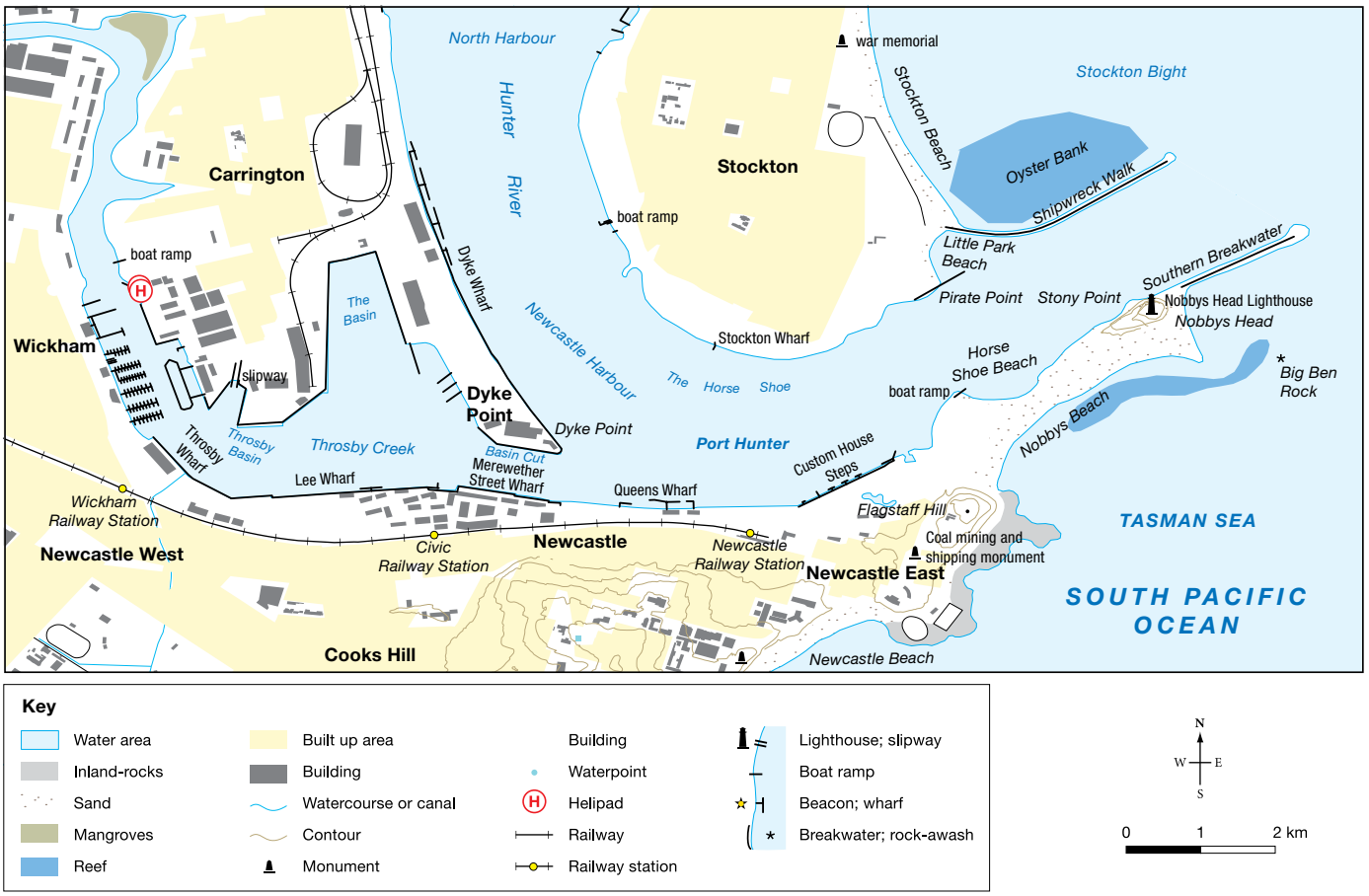


FIGURE 8 The Port of Newcastle is the largest bulk shipping port on the east coast of Australia.



Source: Land and Property Information, NSW.

ACTIVITIES

IDENTIFY

1 What is the ***interconnection*** between the World Trade Organization and Australia's trade?
2 What are Australia's three most important exports and imports?
3 Refer to figure 8. Identify three features of Newcastle Harbour that make it ideal for a shipping port.

EXPLAIN

4 Refer to figures 3 and 4. Compare Australia's imports and exports with those of Asian countries. Use data in your response.
5 Despite having a relatively small population, Australia has many goods and services to trade. Explain why this might be so.
6 Using the **Australian trade partners** weblink in your eBookPlus, describe the trade connection that exists between Australia and one other trading partner.

APPLY

7 How might a ***change*** in the growth of Australia's population affect the country's agricultural exports?
8 Look at the list of goods that Australia imports shown in figure 6. What factors could lead to a ***change*** in the types of goods imported by the year 2050?

INVESTIGATE

9 a What evidence is there in this section to confirm the fact that Australia is regarded as mostly a primary industry exporter?
b Research the way in which an opportunity to trade with Australia is promoted overseas.
c Prepare a brochure for students from a country of your choice that promotes study in Australia.

eBookplus

Interactivity
Trading partners
Use this interactivity to further your understanding of the interconnection between Australia and its trading partners.
Searchlight ID: int-3338
Weblink
Australian trade partners

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **› Aid, migration and trade**

19.5 How is food traded around the world?

19.5.1 Trade in food

The world's population is unevenly distributed across space, as is the quantity of food produced. Some places, such as Australia, produce an abundance of food, while others struggle to produce enough to maintain food security.

Traditionally, food production consisted of hunting and gathering or cropping and herding. Excess food was consumed locally or sent to nearby markets for **barter** or cash. While up to 41 per cent of the world's population is still directly tied to subsistence agriculture, many of the world's highly developed economies produce large surpluses of food specifically for international trade. For instance, Australia's food production is estimated to be worth $163.4 billion annually, and of that, $35.8 billion-worth is exported.

barter to trade goods in return for other goods or services rather than money

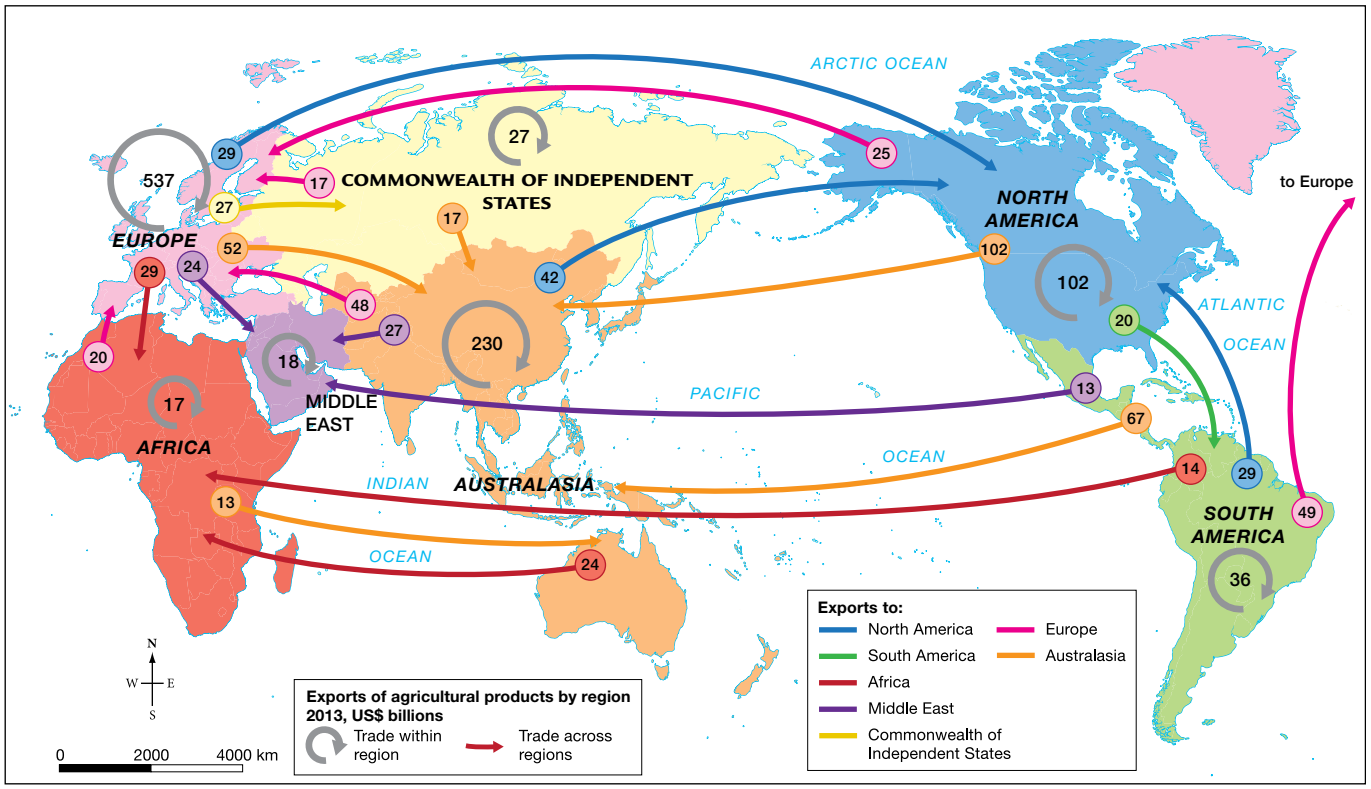
The flow of food trade

Much of the flow of food trade is controlled by powerful nations, such the United States, the European Union and China, and by international food trade agreements. The World Trade Organization (WTO) and G20 (a group of 20 highly developed and powerful nations) have a significant say in the flow of food products around the world, particularly with respect to tariffs and **fair trade** rules.

Food trade is a complicated business, as can be seen in figures 1 and 2. It is estimated that for developing countries, three-quarters of exports are agricultural produce. While developed countries may need to import tropical foods, many actually export as much as they import in agricultural produce. For instance, the United States, Canada and Australia use large farms to produce wheat, and they control 75 per cent of the global export trade in cereals.

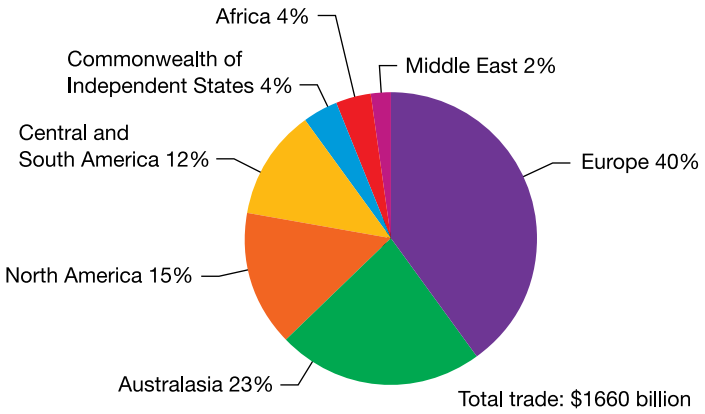
fair trade a consumer-driven movement to promote fair prices and reasonable conditions for producers in developing regions. Fairtrade International is a group of 25 organisations trying to ensure a better deal for producers.

FIGURE 1 World trade flows — exports of agricultural products by region, US$ billion



Source: Spatial Vision

FIGURE 2 Agricultural exports, share by region, 2013



Trade in animals

World trade in animals as food is estimated at close to 50 million animals — pigs, cattle and sheep. Using modern shipping methods, many animals are transported over long distances, and questions have been asked about potential cruelty in the operation of this trade (see figure 3).

The livestock import policies that our trading partners introduce may have an impact on the volume of Australian livestock exports. The aim of exporting live animals is that they are slaughtered according to **halal** religious customs in the country of import.

halal describes food that is prepared under Islamic dietary guidelines

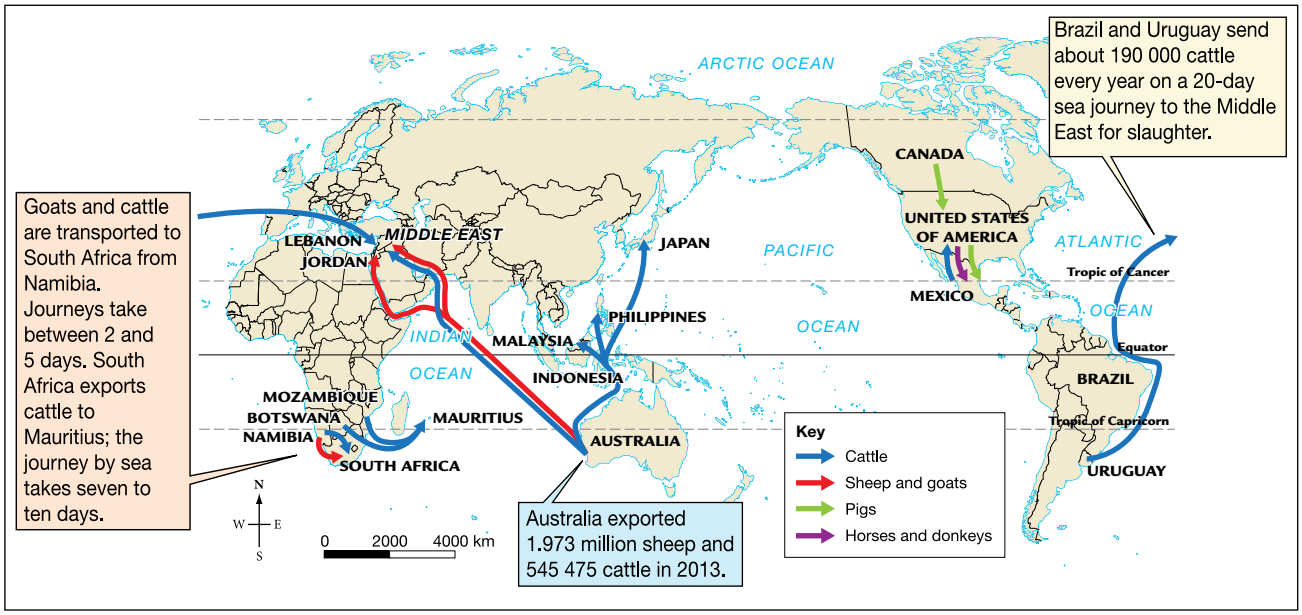
Due to the extensive nature of farming cattle and sheep in Australia, these animals must often travel very large distances to reach ports. They then travel by ship to distant markets.

Where does my food come from?

As a result of the global trade of fresh and processed foods, it may be difficult to determine where your food has come from. For example, a packet of sultanas bought at a local supermarket and labelled 'Made in Australia' may be made entirely of ingredients that have been imported from another country, such as Turkey. The packaging may be stamped with a 'Made in Australia' label because the contents have been processed and packaged in an Australian factory.

New food labelling laws in Australia are designed to protect shoppers by listing the place of origin of food they are about to buy and eat. Customers can then make an informed choice about buying ingredients and produce grown or prepared locally or in other countries.

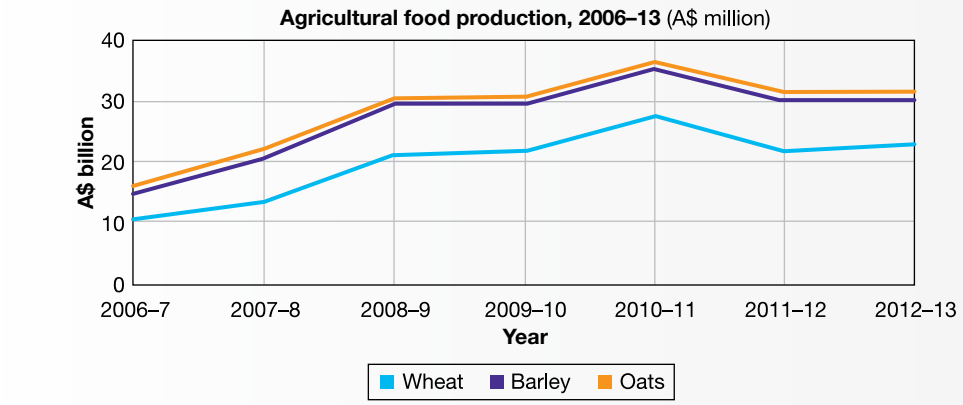
FIGURE 3 Live animal transport around the world



Source: Spatial Vision

GEOskills TOOLBOX

Cumulative line and bar graphs allow you to display and compare factors on the same graph over a period of time. The following graph shows the amounts of wheat, barley and oats produced in Australia between 2006 and 2013. This graph shows an increase in wheat and barley production, while oats production has remained stable between 2006 and 2013.



eBook*plus*

Weblink
Trade

ACTIVITIES

IDENTIFY

1 What is the value of Australia's food exports?
2 Suggest why highly developed economies are able to produce food surpluses.
3 Refer to figure 1.
  a What is the value of food trade from Australasia to Europe?
  b What is the value of food trade from Europe to Australasia?
  c Is there a balance in this food trade based on your calculations in (a) and (b)?
  d Place the regions of the world in decreasing order by volume of food trade.

EXPLAIN

4 Refer to figure 2.
  a Explain why Africa has such a low level of food trade.
  b What reasons can you suggest as to why Europe dominates world food trade with a value of 40 per cent?
  c Why do you think Oceania is not represented?

APPLY

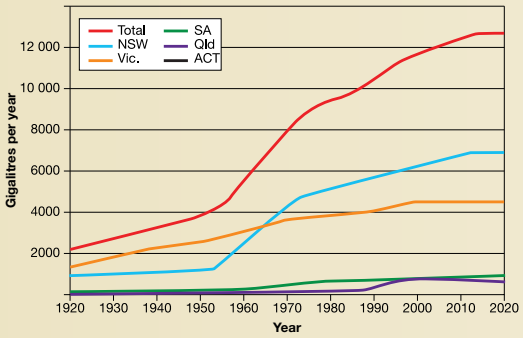
5 Why do countries in ***places*** such as the Middle East and Asia have a preference for live animal imports?
6 Use the **Trade** weblink in your eBookPLUS to help you prepare a 200-word statement about the types of agricultural produce Australia exports and the nations to which we export. Also state what agricultural produce Australia imports.
7 a Investigate the issue of live animal exports from Australia.
  b How might a ban on live animal exports from Australia affect farmers?

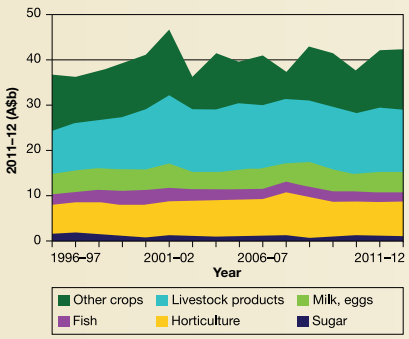
eBook*plus* ONLINE ONLY

19.6 SkillBuilder: Constructing multiple line and cumulative line graphs

What are multiple line graphs and cumulative line graphs?

Multiple line graphs consist of a number of separate lines drawn on a single graph. Cumulative line graphs are more complex to read, because each set of data is added to the previous line graph. Both formats show change over time and show trends effectively. They are both useful when comparing the change in one set of data with changes in other sets of data, and are easier to read than a table of statistics.





eLesson

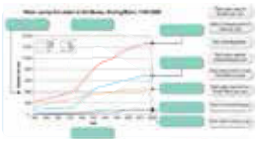
Watch this video to learn how to construct multiple line and cumulative line graphs.



Searchlight ID: eles-1740

Interactivity

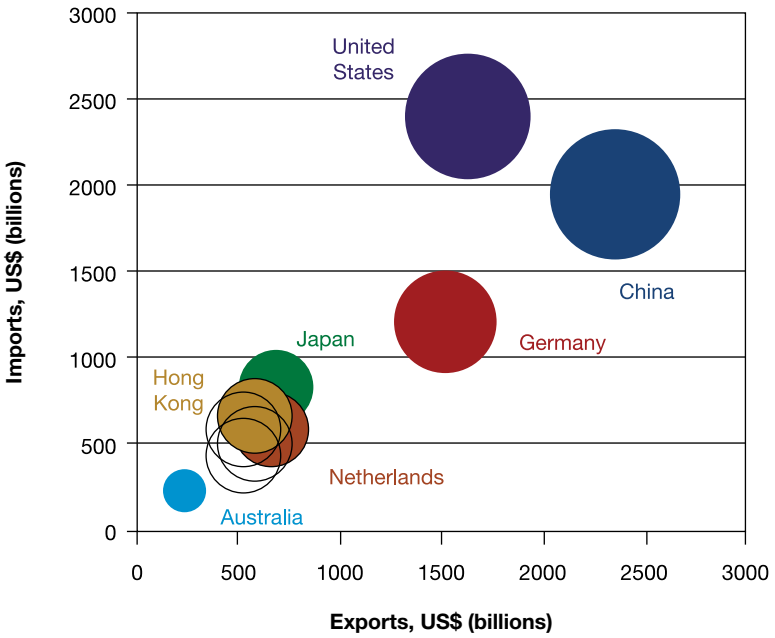
Try this interactivity to learn how to construct multiple line and cumulative line graphs.



Searchlight ID: int-3358

19.7 How are markets and factories linked?

FIGURE 1 A scattergram of the world's leading merchandise traders, 2014



19.7.1 How trade moves around the world

Global trade of resources, manufactured goods and services connects people and places around the world. Information technology enables environments with a competitive advantage in the production of a good or service to connect with destinations that have a need. Transport technology provides an efficient interconnection between source areas, markets and businesses on a global and a local scale.

China is the world's largest exporter of goods, accounting for more than 12 per cent of total exports. The United States is the largest importer, with a share of almost 13 per cent. Growth in world trade patterns continues and global trade is dominated by movements between these strong trading nations. Figures 1 and 2 show the main aspects of this trend.

Global shipping routes

International trade involves the exchange of goods and services between countries. A port is a place for ships to dock on a coastline to load and unload their cargo. A growing global population and the development of an efficient form of goods transport, such as containers, have led to strong shipping links between countries, as shown in figure 2. These interconnections have led to greater choice and more competitive prices for consumers. Economies are boosted and jobs are created worldwide.

FIGURE 2 Global shipping routes

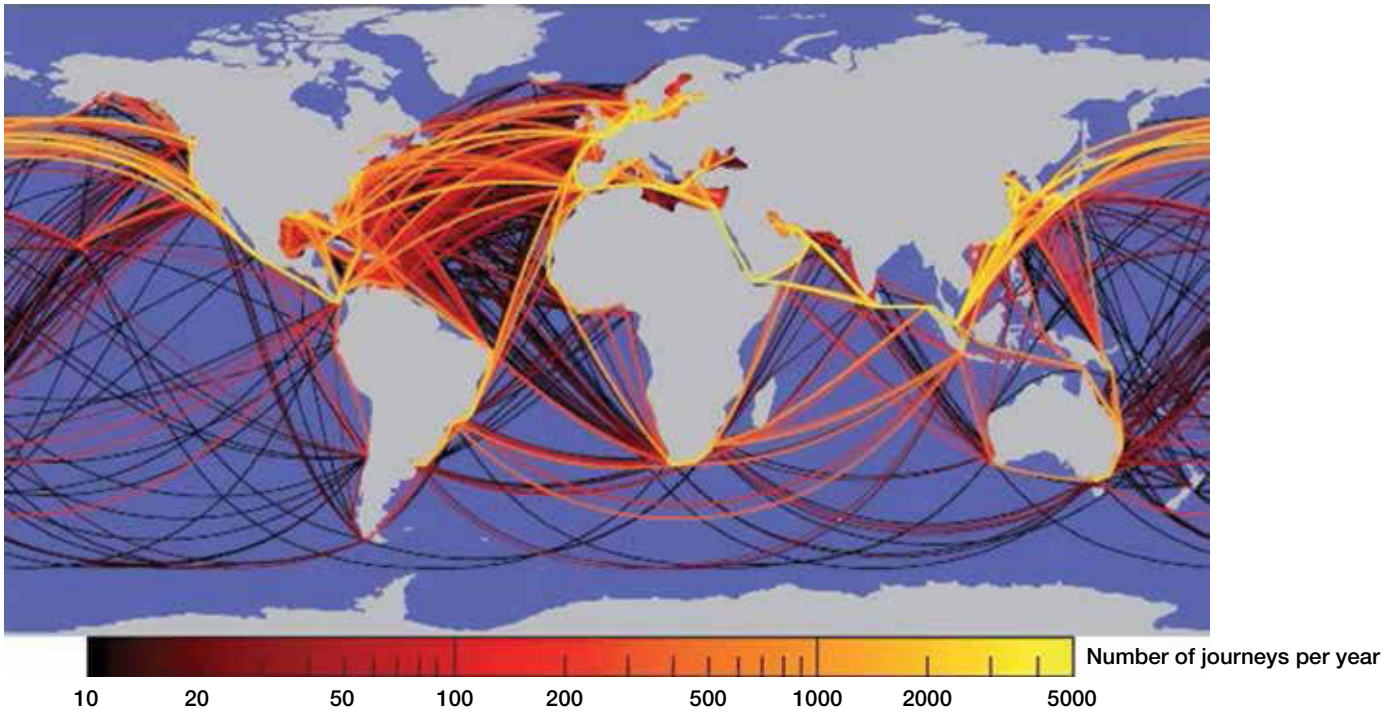


FIGURE 3 The carrying capacity of container ships has increased 1200 per cent since 1968.



Source: Allianz Global Corporate & Specialty Safety and Shipping Review, 2016

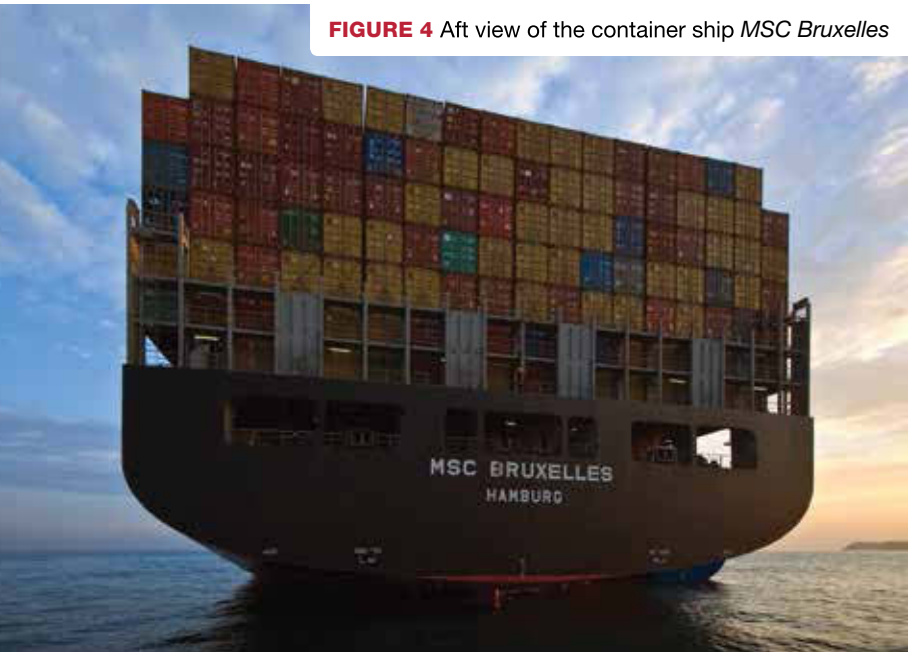


FIGURE 4 Aft view of the container ship *MSC Bruxelles*

The development of the shipping container has created an efficient method of transporting resources and goods from place to place. The introduction of a standardised measure for shipping containers (TEU, which stands for Twenty Foot Equivalent) has shaped the design of cargo ships, port handling facilities and trade routes around the world. Ships are able to carry increasing loads efficiently and more cheaply. For instance, the *MSC Oscar* (figure 3) is able to carry 19 244 containers.

What are port areas like?

Ports are commercial areas where water and land transportation links meet. Efficient handling of the transport of resources and goods will ensure that road and rail networks link the source areas within a country to international air and shipping. These interconnections create employment opportunities in transport and distribution industries. Global Logistics companies manage the movement of trade.

On a global scale, large ports such as Singapore operate 24 hours a day and 365 days a year to load and distribute goods. Raw materials and manufactured goods are distributed to global markets.

FIGURE 5 Inter-modal points manage the transfer of goods.

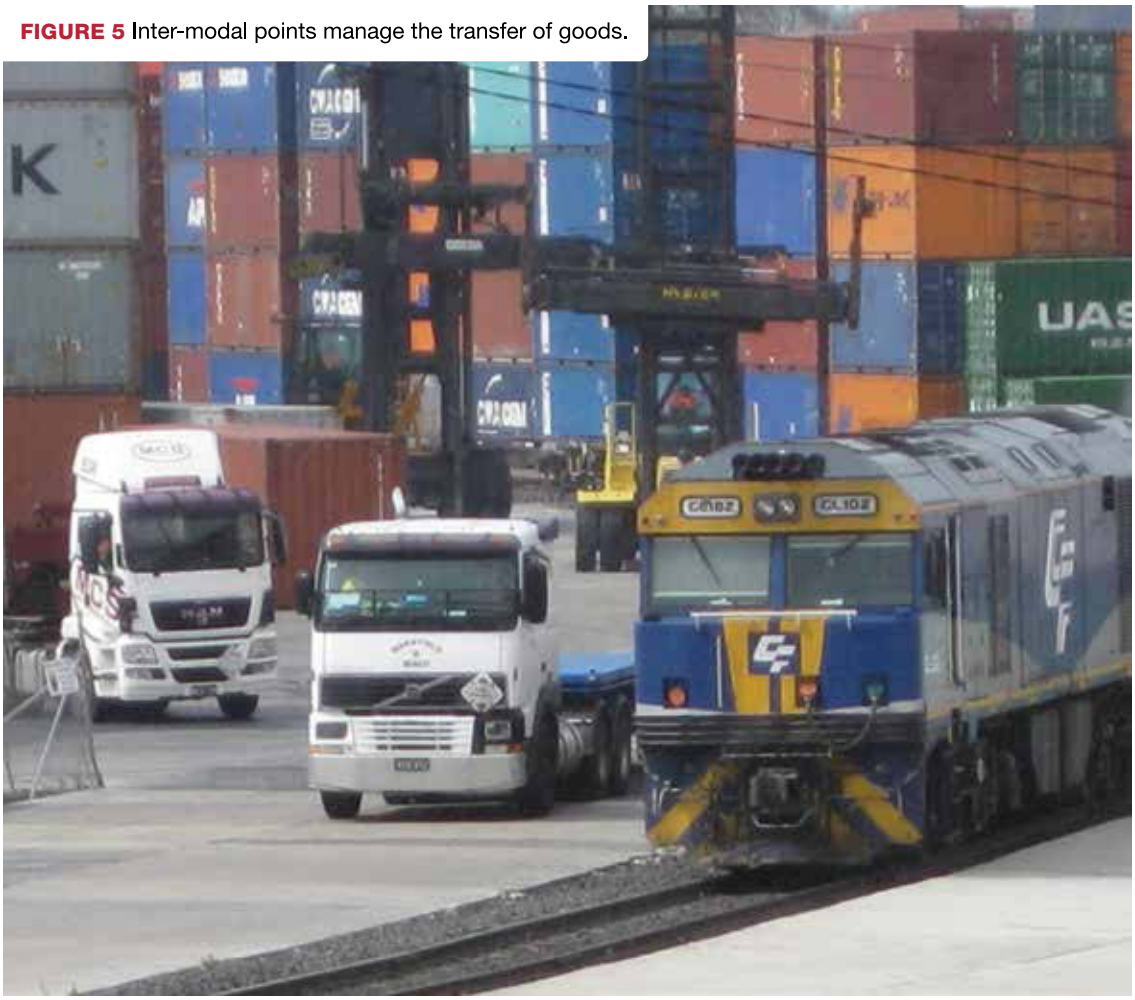


FIGURE 6 Port of Singapore

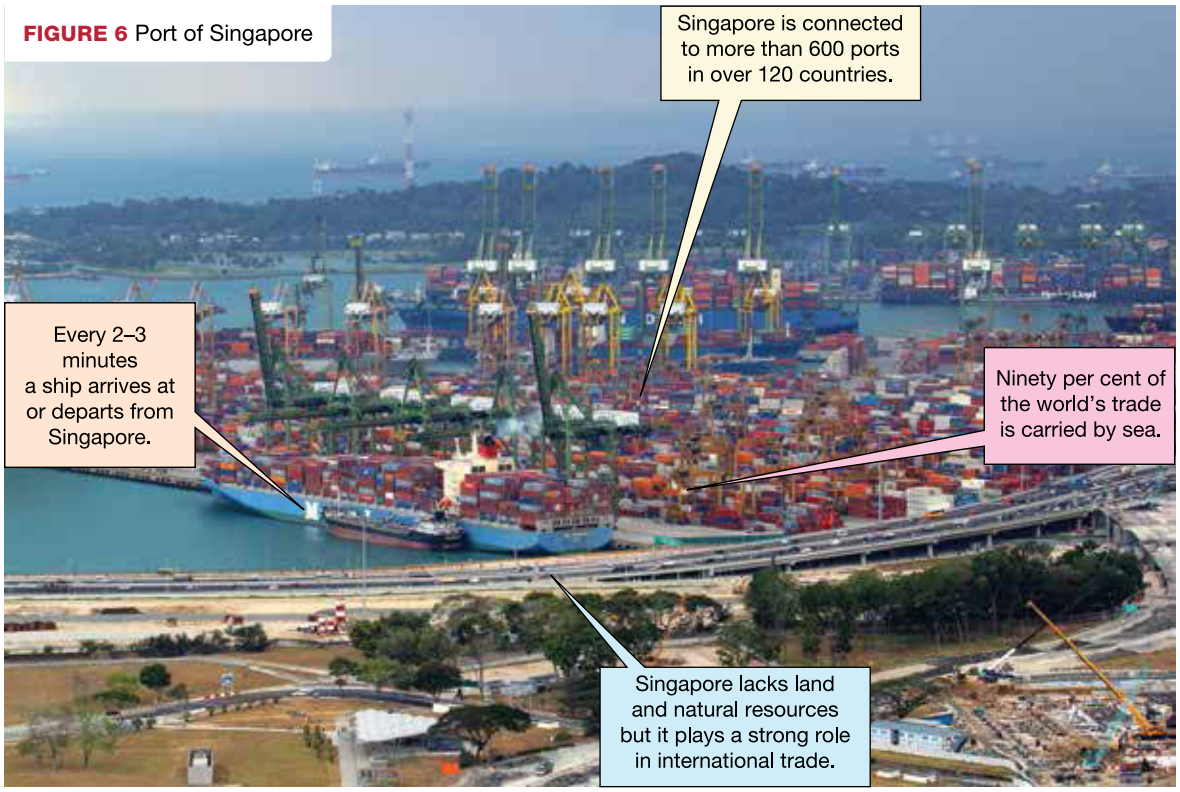
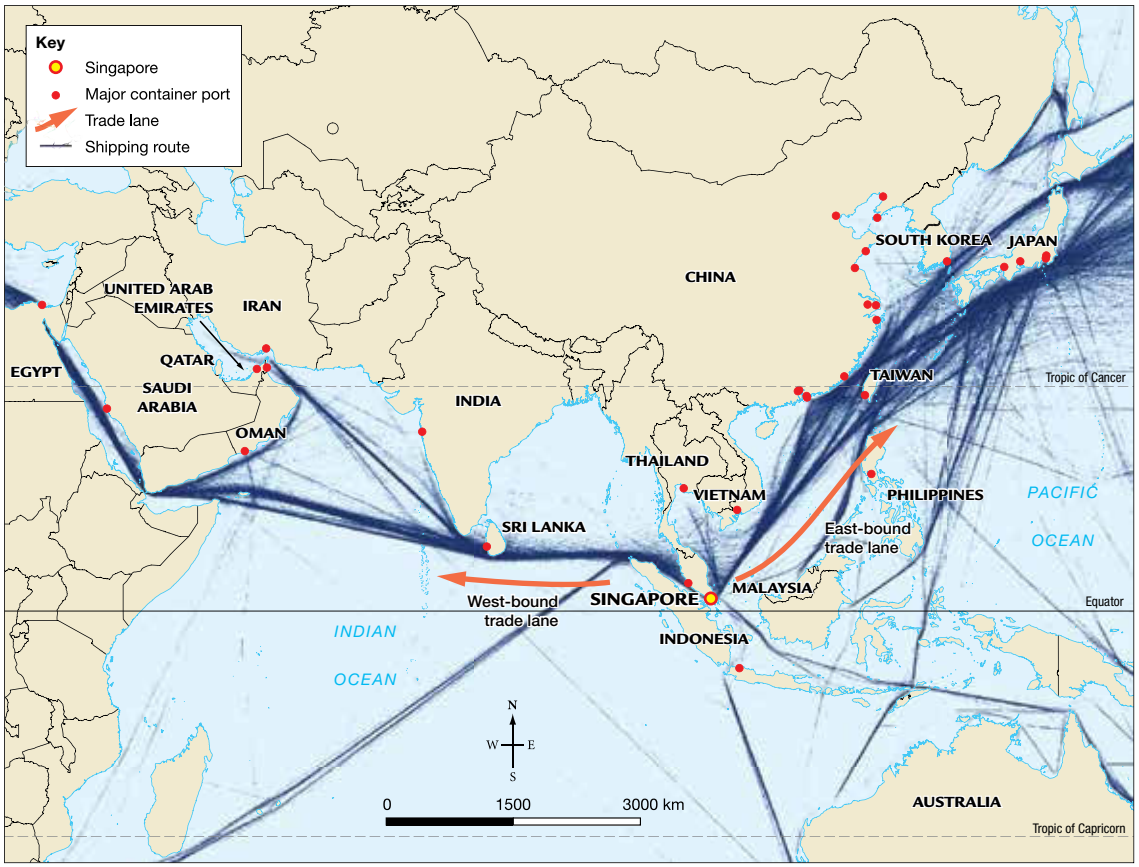


FIGURE 7 Singapore is strategically located where the west-bound and the east-bound trade links pass.



Source: Spatial Vision

How sustainable is shipping?

The capacity of the environment to continue to support our lives and the lives of other living creatures into the future is known as sustainability. Shipping interconnects places around the world through trade. The use of containers makes the process efficient and more reliable, but what are the environmental costs of this industry?

FIGURE 8 Some impacts of the widespread use of containers



Reuse of container to supply housing



Marine debris from shipping accident



Port congestion

Pollution from shipping



Increased influence of globalisation: loss of local jobs, loss of cultural identity



Migration patterns of North Atlantic Right whale disrupted

Damage to World Heritage Areas as a result of increased shipping



Containers used to support earthquake-damaged structures in Christchurch

FOCUS ON FIELDWORK

How is your location connected to larger areas?

Visit a locality that is well connected by transport to areas outside of your location. For example, a local supermarket or shopping centre may be found along a highway or major transport link, or your school may be supported by a range of bus services.

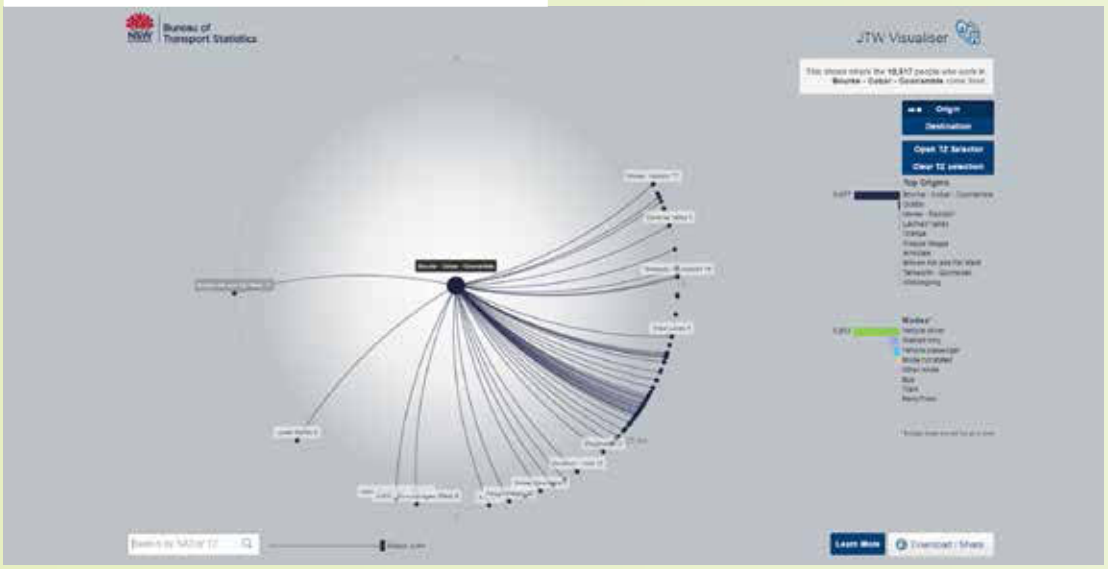
Record your observations. The following questions are a guide.

1 What are the source areas and the destinations of the transport observed?
2 How are passengers or goods moved through the loading dock or interchange area?
3 In what ways do large transport centres have an impact on the environment? Note any strategies that are used to make the flow of people or goods more efficient. This may involve ticket collection and the use of exits for passenger movement. It may involve special lanes for trucks, buses and trains.
4 What are the public transport links that are available for your location? (You can identify these by using the **My public transport links** weblink in your eBookPLUS.)



FIGURE 9 A road and rail transport interchange

FIGURE 10 Pattern of public transport for Bourke



ACTIVITIES

IDENTIFY

1 Which country exports the greatest amount of goods?
2 Which country imports the greatest amount of goods?
3 Refer to figure 1 to rank the top 5 exporting countries in US$ billion.
4 Refer to figure 1 to rank the top 5 importing countries in US$ billion.
5 Refer to figure 2 to describe the shipping routes that have the greatest number of shipping journeys.

EXPLAIN

6 What role does a port play in the movement of global trade?
7 What are the advantages to trading companies of using ships able to carry large container loads?
8 What natural features would a port need to process large volumes of ships each day?

APPLY

9 Prepare arguments for a debate on the topic ‘Shipping is a sustainable option for international trade’. Explore the positive and negative points on this topic and suggest strategies to reduce some of the impacts presented in figure 8.

INVESTIGATE

10 Use the **Ports** weblink in your eBookPLUS. Select one of the ports to investigate. Visit the GIS image of your chosen port and capture a screenshot. Use this image to annotate the key areas of the port. Where do the ships enter the port? What types of goods are traded through the port? What volume of traffic passes through this port?

eBookplus

Weblinks
- My public transport links
- Ports

19.8 How is Singapore linked to other places?

19.8.1 Singapore's strategic location

Singapore plays an important role in connecting places around the world. It has a very strategic location in the heart of South-East Asia, and is an important trade and transport hub. Singapore is an island that borders Indonesia and Malaysia by sea, and its export-oriented economic policy encourages flows of trade and investment.

Singapore is a major transport node. Annually over 55 million passengers pass through Changi International Airport and more than 140 000 vessels pass through the Port of Singapore. The airport is the sixth busiest for international traffic, providing connectivity to over 300 cities worldwide. There are over 27 000 aircraft movements occurring every month (see figure 1) and almost one flight every 90 seconds.

Figure 2 shows Singapore's strategic location at the southern end of the Strait of Malacca, the shortest shipping route between the Indian Ocean and the Pacific Ocean. This stretch of water is the biggest oil corridor in the world and accounts for 25 per cent of all traded goods. At one point the Strait narrows to only 2.8 kilometres, creating shipping congestion and an increased risk of piracy. The Port of Singapore handles a wide range of cargo including containers, motor vehicles and crude oil, which is refined into petrochemical products.

FIGURE 1 Changi airport and port facilities connect Singapore to over 300 countries.



FIGURE 2 The Strait of Malacca links the Pacific Ocean and the Indian Ocean.



Source: Spatial Vision

FIGURE 3 The Causeway Link buses connect Singapore with the mainland.



Singapore consists of 63 islands and is linked to neighbouring mainland Malaysia by road and rail connections. The Causeway Link buses shown in figure 3 enable day workers from Malaysia to commute to Singapore. Singapore is also a popular tourist destination and, in 2015, the Singapore Tourism Board reported that more than 15.2 million people visited the nation.

Interconnections exist between Singapore and its multicultural population. Chinese groups comprise over 74 per cent of the population, with Malay and Indian groups forming over 20 per cent combined. As a former British colony, a member of the Commonwealth of Nations and a founding nation of Association of South-East Asian Nations (ASEAN), Singapore has many links to cultures and economies around the world.

FIGURE 4 Topographic map extract of Singapore



Key

- International boundary
- National capital
- Railroad
- Expressway
- Trunk road
- Primary road
- Ferry
- Port
- Airport
- Park
- 163 m + Spot height

Source: © OpenStreetMap contributors

ACTIVITIES

IDENTIFY

1. Which country is Singapore's closest neighbour?
2. Name the body of water that separates Singapore from its closest neighbour.
3. Identify the country that is found at the following area reference locations.
   a AR2447 **b** AR2544 **c** AR2345
4. What is the area reference for Changi International Airport?
5. What is the direction of Batam from Singapore?
6. What is the direction of Johor Bahru from Singapore?

EXPLAIN

7. Describe the location of ports within Singapore Island as shown on the map.
8. Suggest two advantages of road and rail access to Malaysia for residents of Singapore.

APPLY

9. Use the line scale for the map of Singapore to measure (a) the length and (b) the width of Singapore.
10. Estimate the land area (in square kilometres) of Singapore.
11. What is the distance between Singapore and Batam along the ferry route shown?
12. Research the current population of Singapore. Then calculate the population density of the country using the formula below:
    The population density of a place is: total number of people / area km² = number of people per km².

19.9 How has international automotive trade changed?

19.9.1 The rise of the Asian car industry

Trade is one of the strongest interconnections between people and places on the planet, as goods are transported all over the world. Worldwide earnings from car exports make up 5.3 per cent of earnings from all international exports. Two countries with the largest share of the car export market are Japan in north-east Asia and Germany in Europe. Together, they have 61 per cent of the world's net profits on international car exports. Other countries with significant car exports include China and South Korea in Asia.

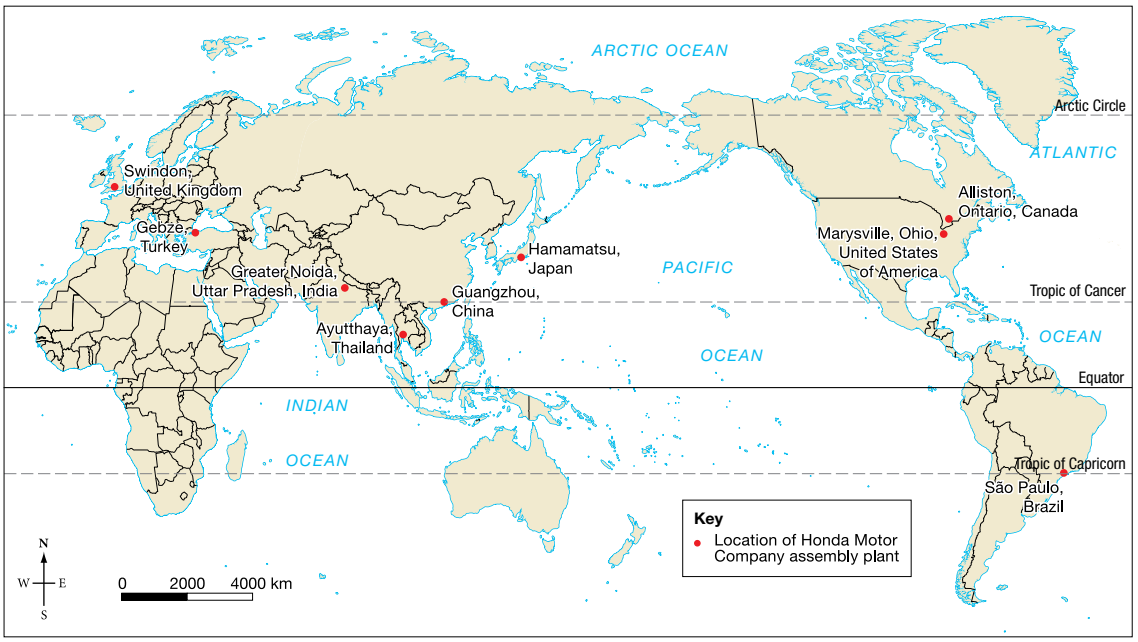
TABLE 1 The world's ten leading car manufacturers, 2015

Rank	Manufacturing company	Headquarters
1	Toyota	Japan
2	Volkswagen	Germany
3	Daimler	Germany
4	BMW	Germany
5	Honda Motor Company	Japan
6	General Motors	US
7	Ford	US
8	Nissan	Japan
9	Hyundai	South Korea
10	SAIC	China

The world's ten leading car manufacturers, according to 2015 data, are found in Asia, Europe and North America. As seen in table 1, Toyota is the world's leading car manufacturer based on revenue, and has assembly and manufacturing plants located around the globe.

Honda Motor Company is a successful Japanese multinational corporation operating plants worldwide. North America is the company's largest market and part of their success is due to car assembly and design taking place in the United States (see figure 1). Honda develops different vehicles to cater to the specific needs of each market. Its vehicles vary by country and may feature models exclusive to one region.

FIGURE 1 The Honda Motor Company operates plants worldwide for the manufacture of their products.



Source: Spatial Vision

19.9.2 The decline of the American car industry

Detroit is the largest city in the state of Michigan, in the United States, and was long known as the world's automotive centre. Detroit and the surrounding region constitute a major centre of commerce and global trade, most notably as home to America's 'Big Three' automotive companies: General Motors, Ford and Chrysler.

These three car manufacturers were, for a while, the largest in the world. Ford had held the position of second-ranked car maker for 56 years, but was relegated to third in North American sales after being overtaken by Toyota in 2007.

The United States car industry is suffering from increased overseas competition and from the 2008–2012 global recession. Car dealerships across the United States are struggling, and many are closing. The Big Three manufacturers have suffered from perceived inferior quality and reliability compared to their Japanese counterparts. They have also been slow to bring new vehicles to the market, whereas the Japanese are considered leaders in producing smaller, more fuel-efficient cars.

FIGURE 2 Sustainable technology will be important for future car sales.



As a consequence, a rise in automated manufacturing using robotic technology (figure 5) has created related industries in Detroit. Inexpensive labour in other parts of the world and increased competition have led to a steady change in certain types of manufacturing jobs in the region. For example, the Detroit area has gained new lithium ion battery plants. As well, the Detroit car makers and local manufacturers have restructured in response to competition. General Motors has invested heavily in fuel-cell-equipped vehicles, while Chrysler has researched and developed biodiesel.

FIGURE 3 Car industry redistribution in the United States



Source: Spatial Vision

Changes to Australia's car industry

Trade enables Australian consumers to access 64 car brands, making Australia one of the most competitive new car markets in the world. Until recently, Holden, Mitsubishi, Toyota and Ford manufactured cars in Australia. A number of factors have contributed to a decision by all four car manufacturing companies to move car production offshore. Australia's relatively high wage costs, withdrawal

FIGURE 4 Australian car imports



of government assistance, the high value of the Australian dollar, and a move by car buyers to smaller cars made it unsustainable for companies to continue producing cars. Australia will continue to provide design, engineering and testing expertise to these companies; however, high levels of unemployment are expected in areas of Victoria and South Australia where car-making plants were concentrated.

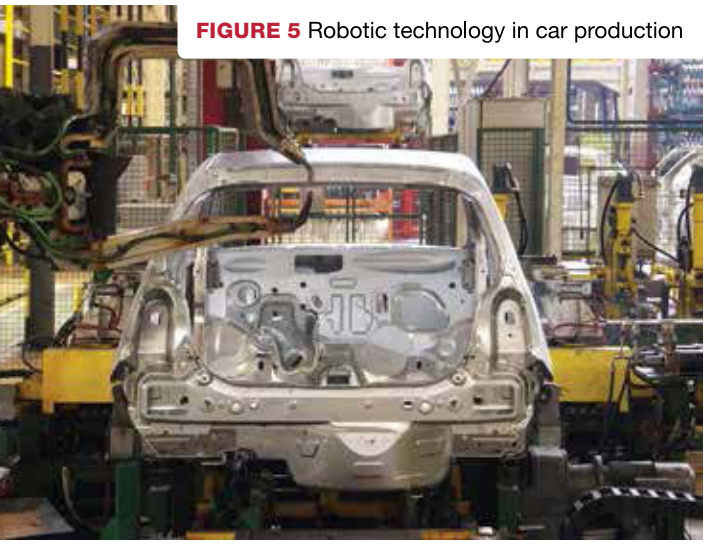


FIGURE 5 Robotic technology in car production



FIGURE 6 The decline of the US car industry has changed employment in Detroit.

ACTIVITIES

IDENTIFY

1 Refer to figure 1. Honda cars are manufactured in many ***places*** around the world. Where is Honda's manufacturing centre for the Australian market?

EXPLAIN

2 Explain the advantages of the Big Three US car manufacturers being located in the same ***place***.

3 Why has the Japanese automotive industry become a world leader in international exports?

4 What ***changes*** have Detroit's industries made in response to the decline of the car industry?

5 Look at figure 3. Describe the location of foreign and domestic automotive plants.

INVESTIGATE

6 Research the effects of the decline of the US car industry on Detroit and surrounding towns and businesses.

7 New Zealand used to have a Honda assembly plant. Find out when it opened, when it closed, and the reason for its closing.

19.10 Are global players altering the industrial landscape?

19.10.1 Changing trends

Until recently, designer clothing came from Italy, and jeans came from the United States. Today, that Italian suit might be designed in Milan, but it is woven from New Zealand wool and stitched together in China. **Globalisation** has brought global marketing, encouraging consumers everywhere to buy goods without a thought to where they come from.

globalisation the process that enables markets and companies to operate internationally, and products and ideas to be freely exchanged

The clothing industry has faced several tough years. Since the global recession (or global financial crisis) in 2008, consumer spending patterns have changed and retailers have experienced a decline in sales. Further changes have occurred due to the growth of online shopping and the signing of Free Trade Agreements.

The Australian clothing manufacturing industry has produced some very recognisable brand names and distinctive products. One challenge facing this industry is international competition, especially from developing countries that can afford to mass-produce clothing more cheaply than Australian companies can. Australian clothing manufacturers tend to focus on high-end, high-quality products rather than attempting to compete with lower-cost producers.

Many multi-national firms have moved production away from the relatively expensive location of Australia, 'off shore' to a relatively cheaper location such as China. These cheaper places offer low labour costs, no labour unions, a stable political system and government incentives designed to attract investment.



FIGURE 1 This symbol signifies that a product has been manufactured in Australia by an Australian-owned company.

Bonds latest brand to head offshore

While iconic Australian clothing brands Bonds, King Gee and Hard Yakka will now be manufactured offshore, the company that owns them insists the heart of the business remains Australian.

However, the decision by Pacific Brands to move its entire clothing manufacturing workforce to Asia means labels like Bonds will be the latest in a long line of Australian brands hoisted overseas.

The trend goes back to the 1920s, when the Vegemite trademark was acquired by United States giant Kraft.

More recently, Arnott's Biscuit Company was bought by US-based Campbell Soup Company in 1997, and Aeroplane Jelly was acquired by Jelly McCormick Goods two years earlier . . .

Cereal company Uncle Toby's was bought by Swiss Nestlé in 2006, and . . . swimwear company Speedo was bought by the United Kingdom–based Pentland Group in 1990.

But [the] Pacific Brands chief executive . . . is adamant that while Bonds singlets and undies will now be made in countries like China, the ideas will continue to come out of Australia . . .

Source: *The Age*, 25 February 2009. © 2009 AAP. See full notice on acknowledgements page.

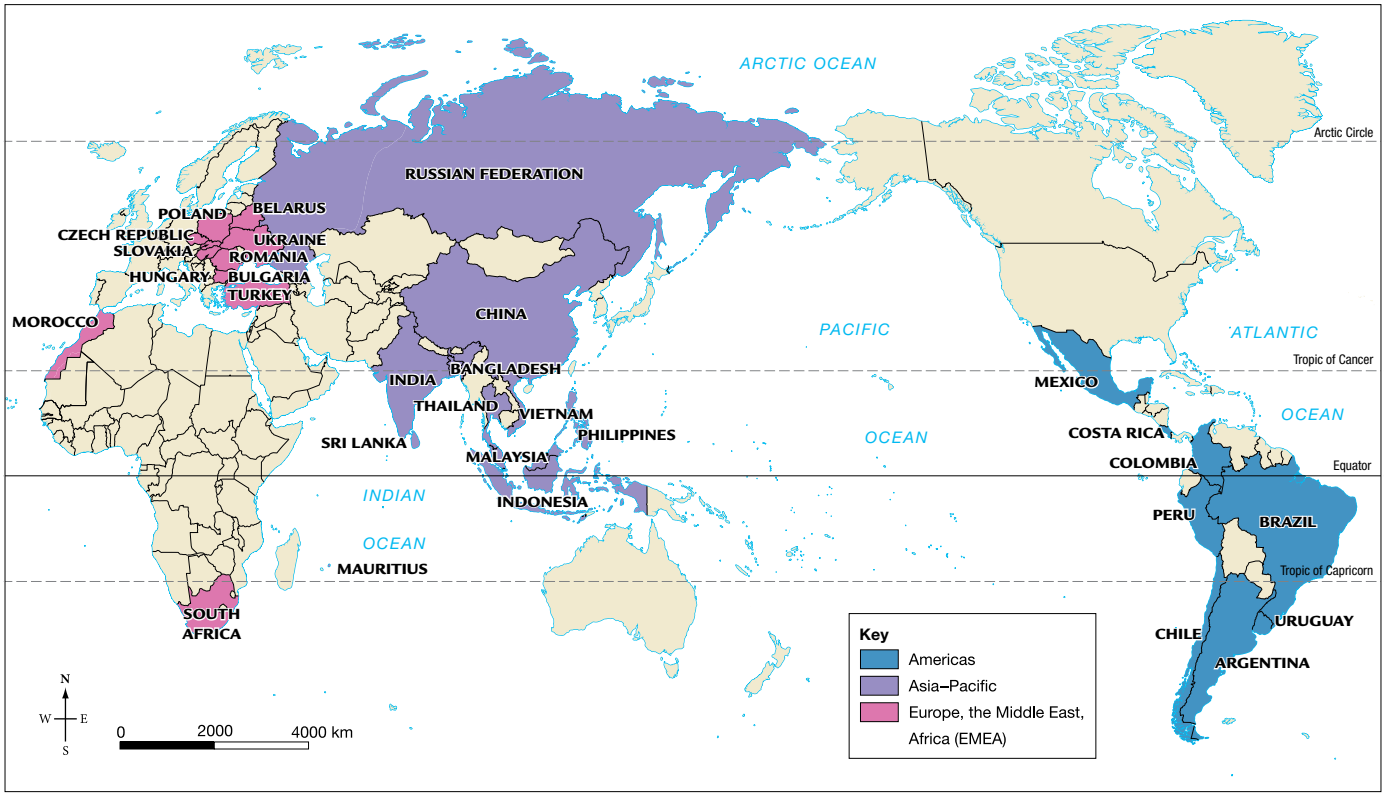
19.10.2 Foreign companies in China

In 1979, there were 100 foreign-owned enterprises in China. In 1998, there were 280 000, and by 2010 there were 300 000. Since 2007, foreign companies employed 25 million people in China. Foreign companies that operate in China include Coca-Cola, Pepsi, Nike, Citibank, General Motors, Philips, Ikea, Microsoft and Samsung.



FIGURE 2 Ikea products have been redesigned with Chinese customers in mind; for example, making bowls deeper for eating rice-based meals.

FIGURE 3 Top 30 locations for offshore companies in 2014, by region



Source: Spatial Vision

19.10.3 Are your clothes made in sweatshops?

If you buy the brands Puma, Nike, Adidas, Mizuno, New Balance, Bonds or Just Jeans, then you may be wearing clothing or footwear that was made in a sweatshop.

A sweatshop is any working environment in which the workers experience long hours, low wages and poor working conditions. Typically, they are workshops that manufacture goods such as clothing. Sweatshops are common in **developing countries**, where labour laws are less strict or are not enforced at all. Workers have to use dangerous machinery in cramped conditions and can even be exposed to toxic substances. Child labour may be used.

Despite the fact that sweatshop workers receive wages, many of them continue to live in poverty. Most are young women aged 17 to 24.

developing country nation with a low living standard, undeveloped industrial base, and low human development index relative to other countries

FIGURE 4 Bangladesh sweatshop



FIGURE 5 Activists in New York raise awareness of Bangladesh's Rana Plaza garment factory deaths.



ACTIVITIES

IDENTIFY

1 Why have many countries moved their production to offshore ***places***?
2 What are sweatshops?

EXPLAIN

3 What ***change*** do you think online shopping will make to the Australian retail industry?
4 What do you think would happen to the price of clothing if sweatshops were to close down?

APPLY

5 Look at figure 3. Give reasons why most offshore manufacturing companies are located in the Asia-Pacific region.
6 What impact does moving production offshore have on the Australian economy and its people?
7 If clothing carries the Ethical Clothing Australia (ECA) label, it means the garment was manufactured in Australia and the manufacturer has ensured that all people involved in its production received the legally stated wage rates and conditions — known in Australia as award wages and conditions. Find out which Australian-made garments you can purchase to support fair working conditions.
8 How might internet shopping affect ***places*** such as shopping centres?
9 Are sweatshops ethical or ***sustainable***? Explain your answer.

19.11 Why is fair trade important?

19.11.1 Social justice and problems of trade

The benefits of international trade are not evenly distributed around the world, and trade often favours large, developed countries rather than small developing countries. It is the role of governments, organisations and agencies to regulate this trade so that economic benefits are more evenly distributed.

Australians benefit economically, culturally and politically from international trade, but **social justice** problems can arise from this trade. For example, when we import blood diamonds from Africa or carpets made by child labour from Nepal, we are supporting unethical industries.

social justice the aim to create a society that is based on equality, that values human rights, and that recognises the dignity of every human being

In addition, some countries can make it difficult for other countries to compete fairly, on a 'level playing field'. They do this by:

- imposing tariffs — taxes on imports
- imposing quotas — limits on the quantity of a good that can be imported
- providing subsidies — cash or tax benefits for local farmers or manufacturers.

19.11.2 Fair trade

The fair trade movement aims to improve the lives of small producers in developing nations by paying a fair price to artisans (craftspeople) and farmers who export goods such as handicrafts, coffee, cocoa, sugar, tea, bananas, cotton, wine and fruit (figure 1). The movement operates through various national and international organisations such as the World Fair Trade Organization and Fairtrade International (see figure 2).

The fair trade labelling system is operated by Fairtrade International, of which Australia is a participating member. This system works to ensure that income from the sale of products goes back directly to farmers, artisans and their communities. Fairtrade International is present in 74 countries worldwide and has a total of 1210 producer groups (see figure 3). The number of farmers and workers participating in Fairtrade is estimated to be 1.5 million, with 27 per cent of this number being women.

Fairtrade food items currently include sugar, chocolate, coffee, tea, wine and rice. Other products include soaps, candles, clothing, jewellery, bags, rugs, carpets, ceramics, wooden handicrafts, toys and beauty products.

In 2014, Australia and New Zealand had a combined retail sales total of A$ 259 million in Fairtrade Certificate products. Coffee accounted for 75 per cent of sales, followed by chocolate, tea and sports balls. On a global scale, eight million producers and their families have benefited from Fairtrade-funded infrastructure and community development projects.

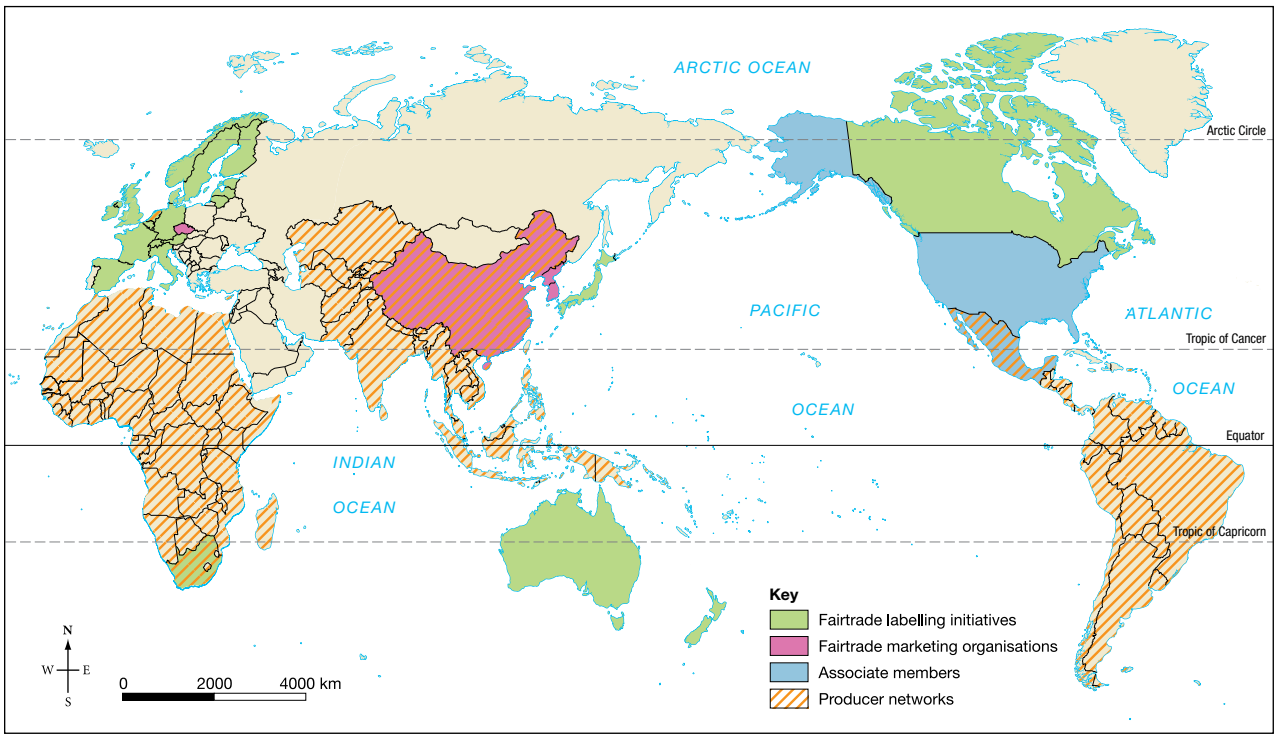
FIGURE 1 Fair trade organisations promote fair labour practices.





FIGURE 2 Goods produced by workers for the World Fair Trade Organization mission

FIGURE 3 Fairtrade International member countries



Source: Spatial Vision

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

Non-government organisations and fair trade

Non-government organisations (NGOs) such as Oxfam and World Vision also support fair trade, and oppose socially unjust trade agreements. They oppose attempts by developed countries to:

- block agricultural imports from developing countries
- subsidise their own farmers while demanding that poor countries keep their agricultural markets open.

ACTIVITIES

IDENTIFY

1 What are the main principles of fair trade?

EXPLAIN

2 Explain the role of NGOs such as Oxfam in relation to trade.

3 Why can trade be unfavourable to poorer countries?

APPLY

4 Find out more about Fairtrade labelling of products sold in ***places*** such as Australia.

5 What types of goods do Oxfam and World Vision sell in Australia?

6 Find out what Oxfam does to promote fair trade by using the internet to search for their programs.

INVESTIGATE

7 Use the **Ethical choices** weblink in your eBookPLUS to discover ethical shopping for clothing. Prepare a wallet-sized checklist for shoppers to inform them of ethical shopping for clothing tips.

8 Online ordering of goods has become a feature of the internet age. Make a list of the advantages and disadvantages of online ordering for workers in the Australian retail industry (such as those who work in department stores).

9 In theory, every country, rich or poor, should have the opportunity to benefit from international trade. However, the reality is very different. Discuss.

10 Australia has made stronger regional trade ***interconnections*** with its neighbours by lowering its tariffs on imported textiles, clothing and footwear. How has Australian trade benefited from this?

eBook*plus*

Weblink
Ethical choices

19.12 Why does Australia give foreign aid?

19.12.1 Foreign aid aims

Countries give aid to other countries in order to help people overcome poverty or humanitarian crises. This often helps the donor country by promoting stability and prosperity in the region. Foreign aid may be delivered in a number of ways such as emergency shelter, water, medical expertise, education and training, building programs, financial assistance as well as law enforcement.

Over one billion people in the world live in poverty and do not have easy access to education and health care. When disasters strike, they lack the resources to get back on their feet. Poverty needs to be addressed by the international community, because it can:

- breed instability and **extremism**
- cause people to flee violence and hardship, thus swelling the number of refugees.

Australia takes the stance that helping people who are less fortunate is a vital way of supporting **humanitarian principles** and social justice. Apart from showing we care, it is in the interests of our **national security**. It also increases our status throughout the world and creates political and economic interconnections with our Asia–Pacific neighbours.

Australia is a member country of the Organisation for Economic Co-operation and Development (OECD). One form of foreign aid contributed by Australia is Official Development Assistance (ODA). In 1970, the United Nations set the international community a target of 0.7% of a country's national income for foreign aid spending. The contributions made by OECD members, including Australia, are displayed in figure 1.

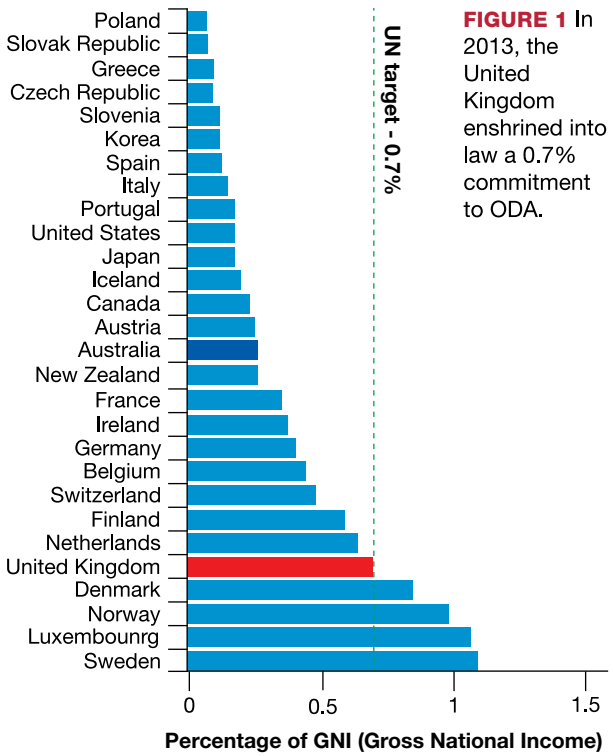


FIGURE 1 In 2013, the United Kingdom enshrined into law a 0.7% commitment to ODA.

extremism extreme political or religious views or extreme actions taken on the basis of those views

humanitarian principles the principles governing our response to natural disasters, such as tsunamis and earthquakes, or human-induced disasters, such as armed conflicts — the main aim being to save lives and alleviate suffering

national security the protection of a nation's citizens, natural resources, economy, money, energy, environment, military, government and energy

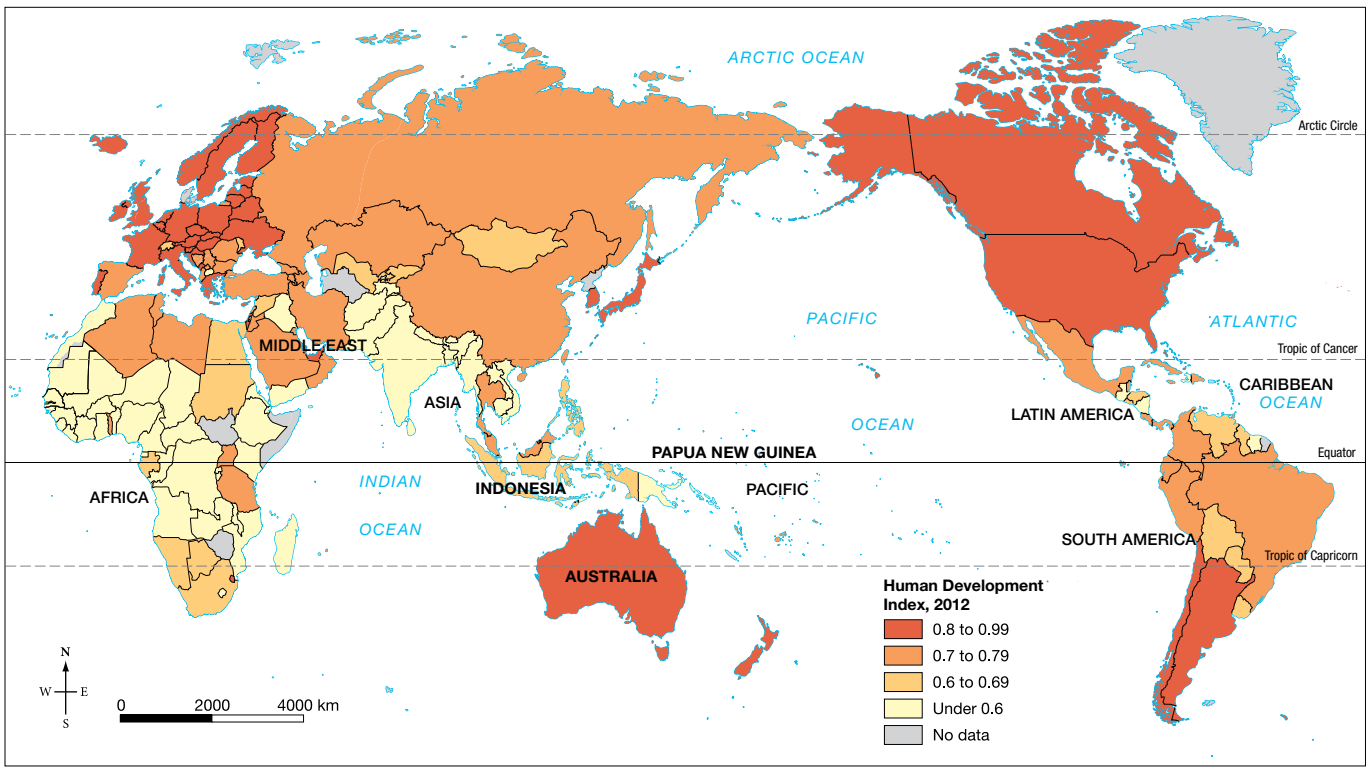
FIGURE 2 Sustainable Development Goals



Sustainable Development Goals

The aim of Australia's foreign aid program has become more focused on promoting sustainable economic growth in developing countries and to create opportunity for communities in poverty. This new approach to foreign aid has coincided with the adoption by the United Nations of 17 Sustainable Development Goals (SDGs) as seen in figure 2. The SDGs replace the Millennium Development Goals (MDGs) which helped lift 700 million people out of extreme poverty. By 2030, 62 per cent of people around the world are projected to live in extreme poverty, especially in places facing conflict. To ensure that funds reach the needy, DFAT works with Australian businesses, non-government organisations such as CARE Australia, and international agencies such as the United Nations (UN) and the World Bank.

FIGURE 3 The Human Development Index (HDI) ranks a country according to life expectancy at birth, adult literacy, school enrolments and income.



Source: Spatial Vision

Sustainability is the careful use of natural resources, such as water, forests, minerals and soil, in such a way that enables future generations to meet their needs. Farming practices that return nutrients to the soil, limiting the size of fish catches to ensure fish stocks can regenerate, and selectively cutting trees for timber are all examples of the ways we can practise sustainability. The United Nation's SDGs promote sustainable development.

The global Human Development Index rankings are shown in figure 3. The countries that have the lowest rankings need ongoing support and assistance to achieve sustainable development.

FIGURE 4 Australia's aid is more focused on the Asia-Pacific and Indian Ocean regions.

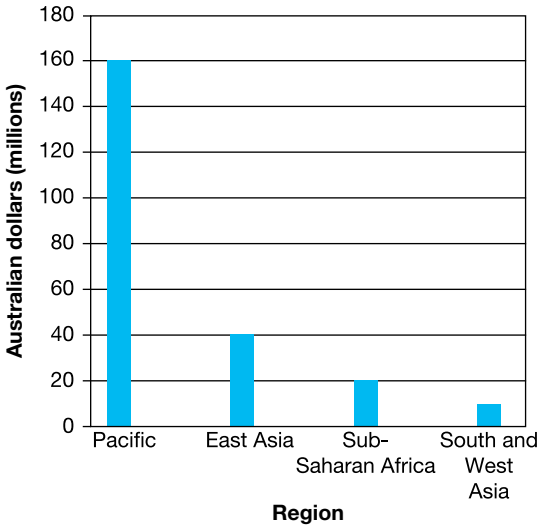


FIGURE 5 Emergency supplies of food and water assist communities severely affected by natural hazards.



FIGURE 6 Australian aid in the Pacific region



FIGURE 7 Bulk quantities of aid are delivered by the Australian defence force.



ACTIVITIES

IDENTIFY

1 What forms of foreign aid are donated by countries?

2 What regions of the world receive most of Australia's aid funding and why do you think this is so?

EXPLAIN

3 What reasons can you put forward to explain why Australia's foreign aid programs are worthwhile in terms of Australia's ***interconnections*** with its neighbours?

4 Is there a case that could be argued for cutting aid budgets? Explain your reasons.

INVESTIGATE

5 Conduct internet research to find out how the Sustainable Development Goals guide Australia's foreign aid program.

6 **a** Why is the Pacific region such an important ***place*** for the distribution of Australian aid?

b Why does South and West Asia receive little foreign aid from Australia?

APPLY

7 If Australia were to stop donations of aid, what ***changes*** do you think this would have on Australia's reputation in the international community?

8 What elements of Australia's aid do you think will have the greatest impact on the lives of people in the Pacific region? Give reasons for your selection.

9 Can you suggest a better way of distributing the budget dollars of the Australia's aid program in order to improve the lives of people in the Asia-Pacific region?

10 If Australia's economic prosperity were to decline in the next 50 years, what elements of Australia's aid program do you believe would not be ***sustainable***?

eBookplus ONLINE ONLY

19.13 Why is the illegal wildlife trade a cause for concern?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

19.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

19.3 SkillBuilder: Constructing and describing a flow map

19.3.1 Tell me

What is a flow map?

A flow map is a map that shows the movement of people or objects from one place to another. Arrows are drawn from the point of origin to the destination. Sometimes these lines are scaled to indicate how much of the feature is moving. Thicker lines show a larger amount; thinner lines show a smaller amount.

Why is a flow map useful?

A flow map is used to give us a visual image of the movement of something that might otherwise be provided through a set of statistics or a lengthy paragraph of text. Interconnections between destinations and places of origin are made very clear, and regional patterns can be readily identified.

Flow maps are useful when trying to understand:

- individual movements, such as use of transport systems and aisles in supermarkets
- local movements, such as traffic flows at intersections or the use of pathways in parks
- national movements, such as the importation of cars to Australian states
- regional movements, such as flows between states of Australia or between countries within the Pacific
- global movements, such as imports and exports, human movement and communication.

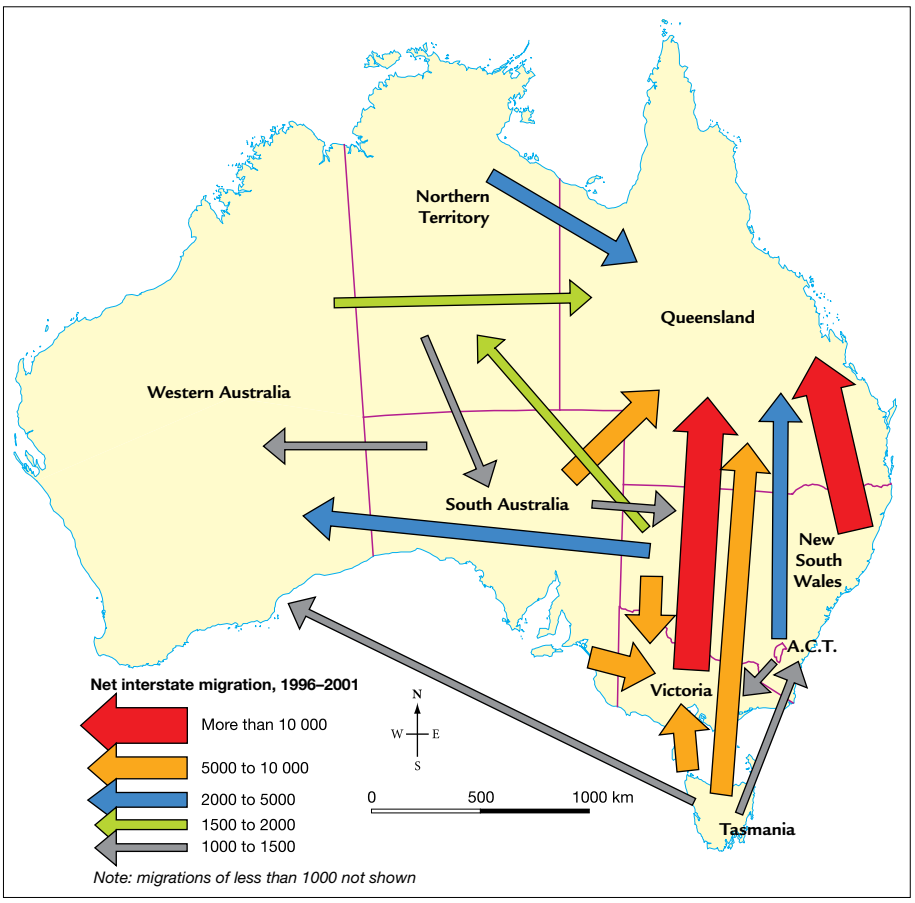
Model

Between 1996 and 2001, people moved from the southern states to Queensland, and from the eastern states to Western Australia (figure 1). All states experienced migration of residents to Queensland, with more than 10 000 from each of Victoria and New South Wales, and 5000–10 000 from Tasmania and South Australia. New South Wales lost more people than it gained, with inflows of 1000 to 1500 from South Australia and Tasmania only. Victoria, however, had inflows from all the surrounding states, including Tasmania (totalling between 16 000 and 31 500), which indicates that Victoria's net loss — more than 10 000 to Queensland — was far less than that of New South Wales, which had a loss of 13 500 to 17 000 or more.

A good flow map:

- is drawn in pencil initially and then coloured appropriately
- uses arrows to indicate flow directions
- may use scaled arrow widths, which are also explained in a key/legend

FIGURE 1 Interstate migration flows, 1996 to 2001



Source: Spatial Vision

- includes labelled features as necessary
- has a clear title, which identifies places and dates.

A description of a flow map:

- identifies and communicates key features of the movement, patterns and places shown
- clearly represents and communicates the data with the use of statistics, places and dates.

19.3.2 Show me

How to construct and describe a flow map

eBookplus

eLesson
Constructing and describing a flow map
Searchlight ID: eles-1741

You will need:

- a set of data that shows the movement of some object
- a base map that corresponds to the places included in your data set
- a light grey pencil
- a set of coloured pencils
- a ruler
- an eraser.

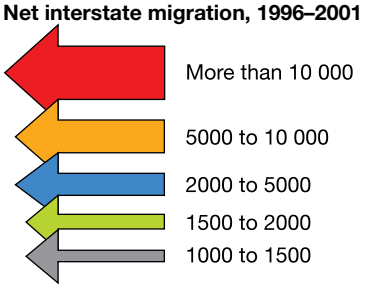
Procedure:

To complete a flow map, you will need to convert a table of data to a coloured map.

STEP 1

If you are planning to simply show the flow between places, then you need only identify each place and draw an arrow from the origin to the destination, as shown in figure 1 in subtopic 19.2. Writing numbers on the flow lines is another method for creating a basic flow map. (If you use this method, go now to step 5.) On the other hand, if you want to create a map that provides an instant snapshot of the quantities of a feature being moved, then a scaled flow map is a better option. Your first step is to determine the scale you will use. Look over the data set that you have, and establish no more than five categories that will allow you to represent the data. Figure 2 shows how these appear in the key of figure 1.

FIGURE 2 Scaled arrows for the flow map in figure 1



STEP 2

Draw up the key, or legend, for the base map. Note that you will have to work in millimetres; otherwise, your arrows will dominate the map. In a key such as figure 2, one millimetre could be used to represent 1000 people. This will avoid having very wide arrows for the larger values, and allow the arrows to fit within the map. Label your key appropriately.

STEP 3

Now you need to rule an arrow, of an appropriate width, from a place of origin to a place of destination. Before you begin, think where you will place each arrow, as it is best to avoid overlapping them. This is most important if you are mapping global data; look at figure 1 in subtopic 19.5 to see how complex this can become.

STEP 4

As you draw arrows between the places of origin and destination, use your ruler to keep the arrow widths consistent. Neatness is important. Colour the arrows as you go to avoid confusion at the end.

STEP 5

Ensure that the completed map includes geographical conventions (BOLTSS).

STEP 6

Look at the completed map and identify any patterns that are evident. Is there an interconnection between the widest arrows? Is there an interconnection between the narrowest arrows? Write a few sentences to explain any patterns you can identify. In figure 1, people moved from the southern states to Queensland — more than 10 000 from Victoria, 5000–10 000 from Tasmania, 2000–5000 from the ACT and more than 10 000 from New South Wales. They also moved from the eastern states to Western Australia — 2000–5000 from New South Wales, 1000–1500 from Tasmania, and 1000–1500 from South Australia.

STEP 7

Look for any anomalies in the pattern — arrows that stand out as being different. Write a sentence to identify any anomalies. For example, in figure 1, although Victoria had an inflow from all its surrounding states, including Tasmania, fewer than 1000 Victorians moved to each of the states of Western Australia, South Australia, New South Wales, ACT and Tasmania.

eBook*plus*

Interactivity
Constructing and describing a flow map
Searchlight ID: int-3359

19.3.3 Let me do it

Developing my skills

Using a blank world map and the data in table 1, construct a flow map of ivory smuggled from Africa to Asia. Think carefully about the scale you choose, as the data for China is high. Note that the flow is from Africa to Asia, so the arrows need to go from Africa to the appropriate country in Asia. Write a description of the supply of smuggled ivory to Asia.

TABLE 1 Ten Asian countries with the most ivory seized, 1989–2011 — total weight of seizures in kilograms

India	Singapore	Malaysia	Japan	Philippines	Vietnam	Taiwan	Hong Kong	Thailand	China
6758	8028	8527	8618	10 659	13 426	18 370	20 638	21 364	41 095

Source: TRAFFIC, Tom Milliken

Questions

1. Which Asian country had the most smuggled ivory seized?
2. Which Asian country had the least smuggled ivory seized?
3. Describe the areas of Asia to where smaller quantities of ivory are smuggled and the areas where more smuggled ivory arrives.
4. Does distance seem to affect the amount of ivory smuggled? Explain your answer, using the map ***scale*** to help you.
5. Does the level of a country's development influence the smuggling of ivory? Explain your answer.

Checklist

In drawing a flow map I have:

- drawn in pencil initially and then coloured appropriately
- used arrows to indicate flow directions
- used scaled arrow widths, which are also explained in a key/legend
- included labelled features as necessary
- provided a clear title, which identifies places and dates.

In interpreting a flow map I have:

- identified and communicated key features of the movement, patterns and places shown
- clearly represented and communicated the data with the use of statistics, places and dates.

Skills questions

1. Flow maps are used to show:
   a. the scale of a product
   b. the shape of the land between two places
   c. the movement of goods and people
   d. the level of production.
2. A flow map would never include information about:
   a. the value of goods
   b. the number of goods and people
   c. the rainfall of a place
   d. the type of goods and people.
3. Why do you need to determine origin and destination on a flow map?
4. Why is it useful to use arrows of different widths?

19.6 SkillBuilder: Constructing multiple line and cumulative line graphs

19.6.1 Tell me

What are multiple line graphs and cumulative line graphs?

Multiple line graphs consist of a number of separate lines drawn on a single graph. Cumulative line graphs are more complex to read, because each set of data is added to the previous line graph. Both formats show change over time and show trends effectively.

Why are multiple line graphs and cumulative line graphs useful?

Multiple line graphs and cumulative line graphs are useful when comparing the change in one set of data with changes in other sets of data, and are easier to read than a table of statistics. Sometimes in multiple line graphs the lines may cross one another, so a coloured key is used. Cumulative line graphs are good at showing the breakdown of a total quantity.

They are also useful for:

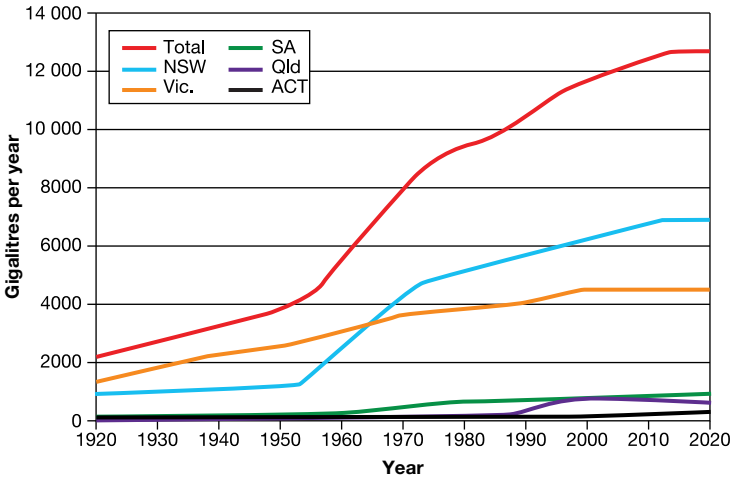
- showing a pattern of change
- comparing changes in components of the total
- showing trends in data.

Model

Good multiple line graphs and cumulative line graphs:

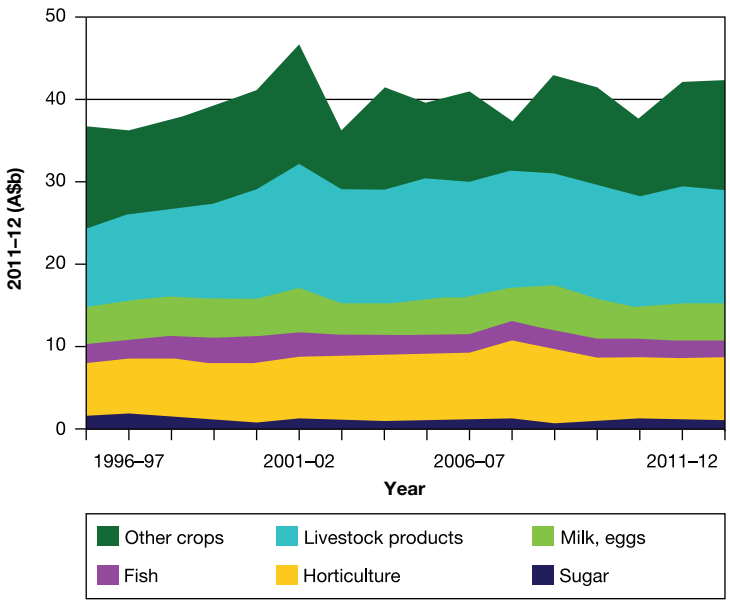
- have labelled axes
- include a clear title or caption that identifies places and dates for the data.

FIGURE 1 Water use by five states in the Murray–Darling Basin, 1920–2020, as a multiple line graph



Source: Food and Agriculture Organization of the United Nations, 2012 FAOSTAT, http://faostat3.fao.org/home/index.html

FIGURE 2 Value of Australian farms and fisheries food production, 1996–2012, as a cumulative line graph



Source: © DAFF 2013, *Australian Food Statistics 2011–12*. Department of Agriculture, Fisheries and Forestry, Canberra. CC BY 3.0.

19.6.2 Show me

How to draw multiple line graphs and cumulative line graphs

You will need:

- data for multiple places or uses shown over time
- access to a computer
- a blank Excel spreadsheet.

Procedure:

To complete multiple line graphs and cumulative line graphs you must have an appropriate set of data to graph. Both types of graphs can be completed from the same data set.

STEP 1

Place all the data into an Excel spreadsheet. At this stage, if you have spaces in your numbers, close them up or replace them with commas, as spaces can create problems in Excel.

eBook*plus*

eLesson
Constructing multiple line and cumulative line graphs
Searchlight ID: eles-1740

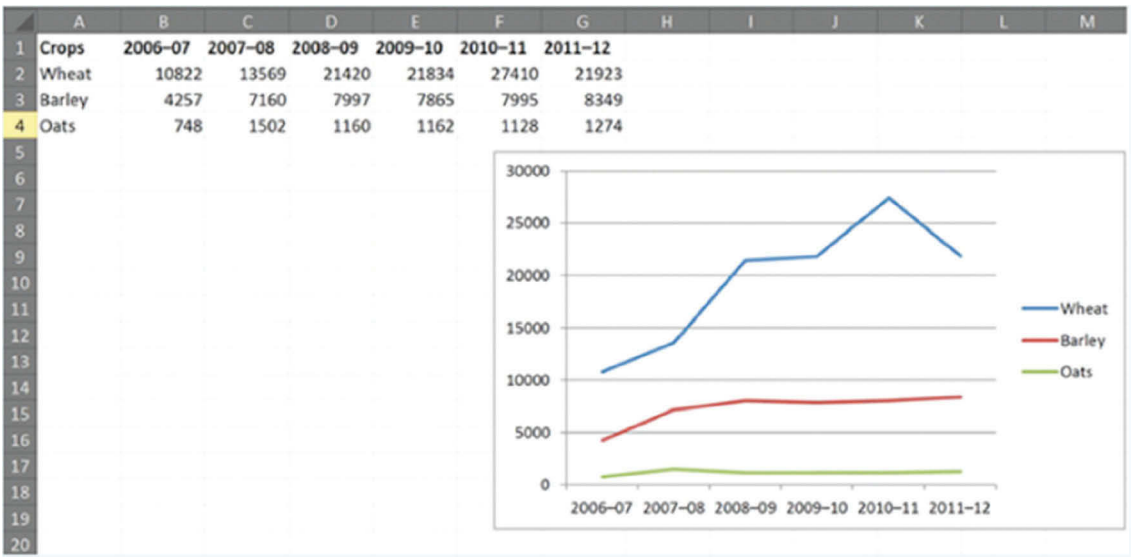
TABLE 1 Agricultural food production, selected grains (1000 tonnes), Australia, 2006–2012

Crops	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Wheat	10 822	13 569	21 420	21 834	27 410	21 923
Barley	4 257	7 160	7 997	7 865	7 995	8 349
Oats	748	1 502	1 160	1 162	1 128	1 274

Source: © DAFF 2013, *Australian food statistics 2011–12*. Department of Agriculture, Fisheries and Forestry, Canberra. CC BY 3.0.

Next, click on the Insert tab and select a multiple line chart (see figure 3). You will then have to add the axis labels. Do this by clicking on your graph's outer border, selecting the Layout tab in the Chart Tools section, clicking on Axis Titles in the Labels section, and following the steps from there.

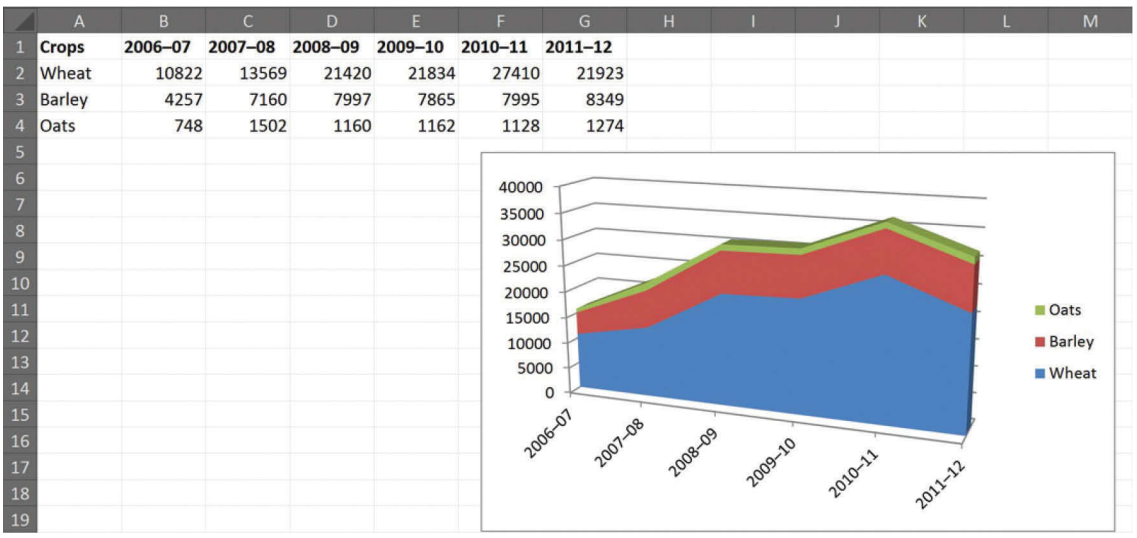
FIGURE 3 An Excel-generated multiple line graph



STEP 2

A cumulative line graph (see figure 4) can be generated by selecting the table data and selecting an Area chart from the Charts section under the Insert tab. Don't forget to add axis labels.

FIGURE 4 An Excel-generated cumulative line graph



STEP 3

Check that you have supplied labels on all axes, units of measurement, and a title or caption.

19.6.3 Let me do it

Developing my skills

Use the following set of data to construct a multiple line graph and a cumulative line graph for four Asian countries to which Australia exports food.

TABLE 2 Australian total food exports by selected destination, $ million, 2006–2012

Country	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
China	664	917	1178	1426	1540	2174
Indonesia	1566	1702	2652	2129	2288	2272
Japan	4752	4553	5517	4278	4207	4448
Republic of Korea	1850	1655	1873	1925	1994	2338

Source: © DAFF 2013, *Australian food statistics 2011–12*. Department of Agriculture, Fisheries and Forestry, Canberra. CC BY 3.0.

Questions

1. Which country received the greatest value of food exports from Australia?
2. Which country showed the greatest change in its level of importation of food from Australia?
3. From 2006 to 2012, which country was most consistent in its level of importation of food from Australia?
4. Suggest why these Asian countries need to import food from Australia.
5. Which graph showed you a clearer picture of the data: the multiple line graph or the cumulative line graph?

eBook*plus*

Interactivity
Constructing multiple line and cumulative line graphs
Searchlight ID: int-3358

Checklist

I have:

- labelled the axes
- included a clear title or caption that identifies places and dates for the data.

Skills questions

1. Multiple line graphs and cumulative line graphs are used to show:
   a. total values of data
   b. single values of data
   c. comparisons between data
   d. mixed data.
2. Multiple line graphs and cumulative line graphs include information about:
   a. money
   b. slope
   c. rainfall
   d. change over time.
3. Why might the lines on a multiple line graph cross over?
4. Why might it be important to carefully calculate totals when constructing a multiple line graph?

19.13 Why is the illegal wildlife trade a cause for concern?

19.13.1 Threatened wildlife

Not all trade is legal. The international trade in wildlife has been one of the factors responsible for the massive decline in many species of animals and plants. Millions of live animals and plants are illegally shipped around the world each year to supply the pet trade and to meet the demand for decorative plants. Wild animal and plant products, such as skins, meat, ornaments, animal parts and timber, are traded in large quantities.

In 1973, an international **treaty** known as the Convention on International Trade in Endangered Species (CITES) was drawn up in Washington to prevent international trade that threatened species with extinction. Any trade in products from threatened wildlife now requires a special permit. Unless there are exceptional circumstances, no such permits are issued for species threatened with extinction. These include species of tigers, elephants, rhinoceroses, apes, parrots and all sea turtles.

treaty a formal agreement between two or more independent states or nations, and usually involving a signed document

The live pet trade

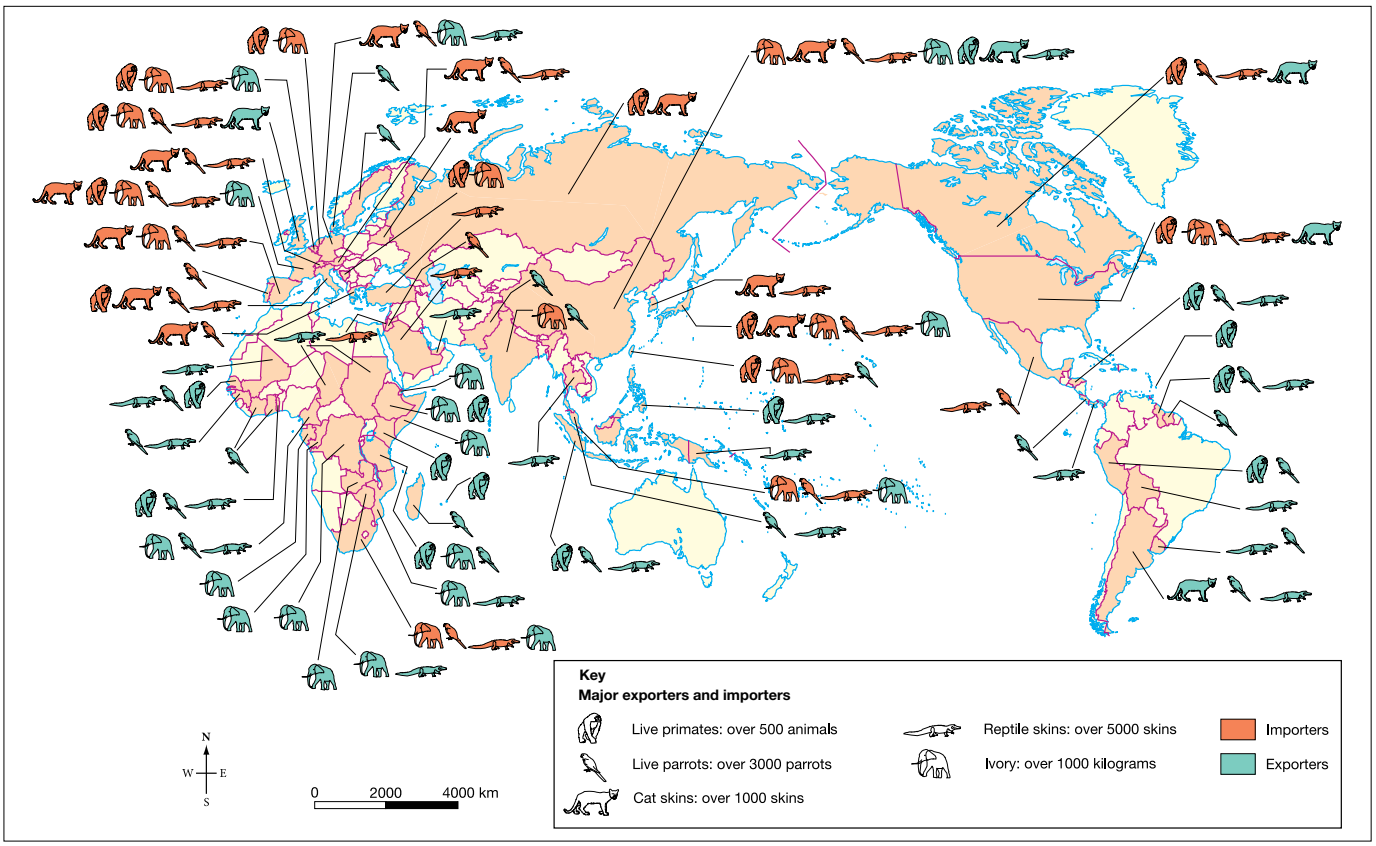
Trade in threatened wildlife still takes place through **smuggling**. Birds are drugged and stuffed into plastic tubes; snakes are coiled into stockings and posted; lizards are stitched into suitcases. Many of the animals die.

Prices on the **black market** can be very high. Bird traffickers can earn more than $150 000 for taking 30 eggs out of a country in specially designed vests that keep the eggs warm. Overseas collectors will pay up to $50 000 for a breeding pair of endangered red-tailed black cockatoos

smuggling importing or exporting goods secretly or illegally

black market any illegal trade in officially controlled or scarce goods

FIGURE 1 Who trades what—exporters and importers of endangered species



Source: MAPgraphics Pty Ltd, Brisbane

FIGURE 2 Some of the skins and stuffed animals seized from poachers in India. The skins were later destroyed to discourage illegal hunting.



Traditional Chinese medicine

Traditional Chinese medicine (TCM), the most widely practised traditional medicine system in the world, uses more than 1000 plant and animal species. While TCM has been practised for perhaps 5000 years, some of the wild plants and animals used are now threatened or in danger of extinction. Among them are certain orchids, musk deer, rhinoceroses, tigers and some bear species.

All five species of rhinoceros are threatened with extinction because people have been hunting them for many years, poaching them just to sell their horns. The horn of the black rhino is sometimes called 'black gold' because it is so expensive. Asian rhinoceros horns are mostly used for medicines said to reduce fever. Horns are cut into oblong pieces and smuggled into other countries in jars of honey, cartons of matches or raw meat.

Rhinoceroses are also endangered because of other factors. Rhinos prefer shade and, owing to the cutting down of trees in grasslands, their source of shelter is being wiped out. Pollution is also endangering these animals; toxic waste and pesticides are left on the grass that the rhinos eat.

Although international trade in rhino horn has been banned under CITES since 1977, demand remains high, and this encourages rhino poaching in both Africa and Asia. Criminal syndicates link the poachers, in places like South Africa, to transit points, smuggling channels and final destinations in Asia. The main market is now Vietnam, where there is a newly emerged belief that rhino horn cures cancer. Rhino horn is used in other traditional Asian medicine to treat a variety of ailments, including fever and blood disorders. It is also used by wealthy Asians as a cure for hangovers.

In October 2011, the World Wide Fund for Nature (WWF) helped to successfully establish a new black rhino population in a safer, more spacious place in South Africa. Nineteen critically endangered black rhinos were transported to a new home. Such relocations reduce pressure on existing wildlife reserves and provide new territory, where rhinos have a better chance of increasing in number. Creating more dispersed and better protected populations also helps keep rhinos safe from poachers.

FIGURE 3 Conservationists dehorning a sedated rhinoceros



ACTIVITIES

IDENTIFY

1 Why are wild species traded?

EXPLAIN

2 Look carefully at figure 1.

a Which categories of wildlife are traded for their skins?

b Using an atlas, list the ***places*** that are the major exporters of the following.

- Live primates
- Cat skins
- Ivory
- Live parrots
- Reptile skins

c Based on your list in (b), list the continents that are the main sources of wildlife species and wildlife goods.

3 Study figures 4 and 5.

a Which two countries in the Asia–Pacific region have high numbers of threatened mammals and threatened birds?

b What reasons can you think of for Indonesia having the greatest number of threatened mammal and bird species?

APPLY

4 Look at figure 2.

a List the smuggled items seized from poachers.

b Suggest what could be done to persuade people not to buy these products.

5 Refer to figure 3.

a How does the action shown support the ***sustainability*** of rhinoceros populations?

b Why are conservationists taking this action?

PREDICT

6 Other than the loss of endangered species, what other negative consequences may occur through the illegal export and import of wildlife?

7 What would be the impact on the Australian ***environment*** if animals such as koalas were to become a target for smugglers?

FIGURE 4 Number of threatened mammal species

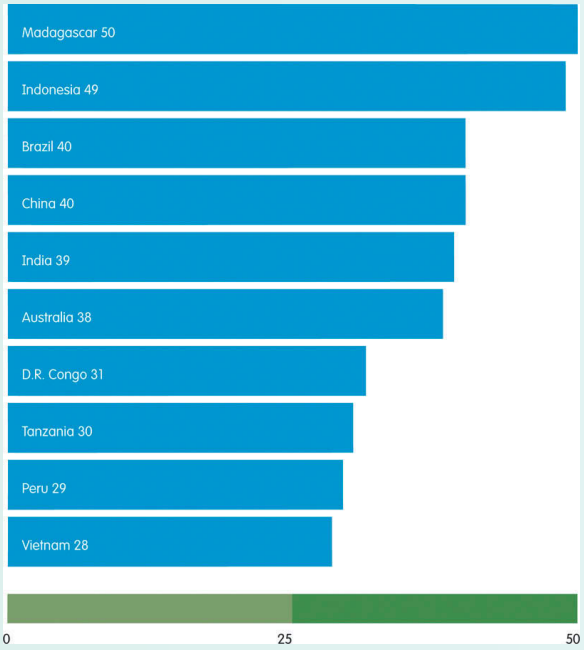
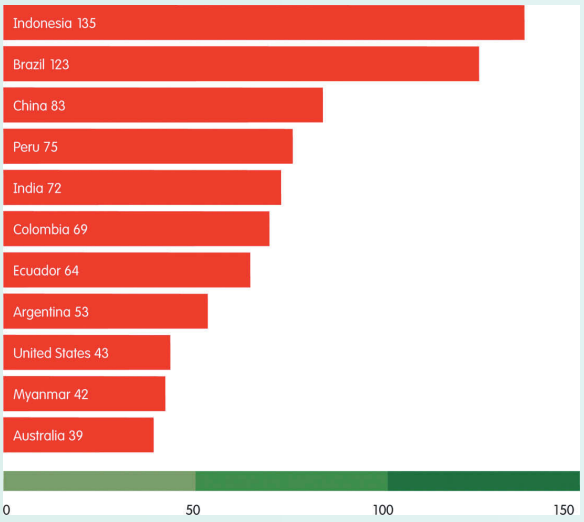


FIGURE 5 Number of threatened bird species



19.14 Review

19.14.1 Review

1. Australia's major trade market has switched from Europe and the United Kingdom to Asia. Suggest reasons for this ***change***.
2. Name the top 10 nations that Australia exports to and imports from. Based on percentage data, draw graphs to represent these trade figures. What do your completed graphs reveal?
3. Why is trade in live animals such a controversial topic?
4. Which two countries have the largest share of the international car export market?
5. The Honda Motor Company has assembly plants in many ***places*** around the world. Why are so many located in developing countries?
6. Why is fair trade such an important idea for countries in the developing world?
7. Why do you think some species become endangered?
8. Does the increase and expansion of the human population have to result in the loss of other species?

19.14.2 Reflect

9. Use the **DFAT** weblink in the Resources tab to answer the following questions.
   a. Where does Australia direct most of its aid?
   b. Australia has recently changed the focus of its aid donations to neighbouring countries in the Pacific and Asian region. Why?
10. Imagine a world without trade. How would this affect your day-to-day life?

eBook*plus*

Weblink
DFAT



e-waste at Agbogbloshie dump, in Accra, Ghana — a dumping ground for electronic waste from all over the developed world

CHAPTER 20

For better or worse?

20.1 Overview

20.1.1 Introduction

The development of technology and communication around the world has both positive and negative effects. One positive outcome is that advances in technology have made people's lives more interconnected. On the other hand, drawbacks include a widening gap between the 'haves' and the 'have-nots', and some negative effects on the environment. Therefore, it is essential to ask whether we are better off or worse off with ever-improving technology and communication.

Starter questions

1. What percentage of students in your class have a mobile phone? How many times a day do you use your mobile phone?
2. If you wanted to discard your outdated mobile phone, do you know how to do so responsibly? Do you think about where your e-waste goes?
3. Have you ever considered how many people in developing countries have access to the internet?
4. When did you last 'Google' the answer to a question?

Inquiry sequence

		Syllabus outcomes
20.1 Overview		
20.2 Who has access to technology?		GE4-2, GE4-3
20.3 SkillBuilder: Constructing a table of data for a GIS	eBookplus ONLINE ONLY	GE4-7
20.4 What are the consequences of unequal access?		GE4-4
20.5 How has technology improved lives in developing countries?		GE4-4
20.6 How has technology improved in Australia?		GE4-3, GE4-4
20.7 How are e-wastes managed?		GE4- 5
20.8 How does e-cycling work?	eBookplus ONLINE ONLY	GE4-4, GE4-5
20.9 How can you reduce your consumption?		GE4-4, GE4-5
20.10 Investigating topographic maps: Can waste be managed more sustainably?		GE4-4, GE4-5
20.11 SkillBuilder: Using advanced survey techniques — interviews	eBookplus ONLINE ONLY	GE4-4, GE4-5
20.12 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



eBook*plus*

Watch this video
Plugging in
Searchlight ID: eles-1725

20.2 Who has access to technology?

20.2.1 Who owns mobile phones

When we think of using the internet and mobile phones, we often forget about those who do not have access. Access is not equal across the world, let alone within Australia.

Today it seems that mobile phones have become the most important form of communication. However, it is interesting to note that not everyone in Australia owns one, and Tasmania actually has the highest proportion of mobile phone ownership (see figure 2).

Mobile phone use across the globe is also uneven. This could be due to a variety of factors, such as access, financial situation and way of life. Some countries, such as Saudi Arabia, have 128–209 mobile phones per 100 individuals, indicating that some people own two devices. Bangladesh is very different, where 1–39 mobile phones are owned per 100 individuals.

expenditure the amount of money spent

infrastructure the features that are built by humans to allow other activities to occur, for example roads, electricity networks and water supply pipes

gross domestic product (GDP) the value of all the goods and services produced within a country in a given period of time. It is often used as an indicator of a country's wealth.

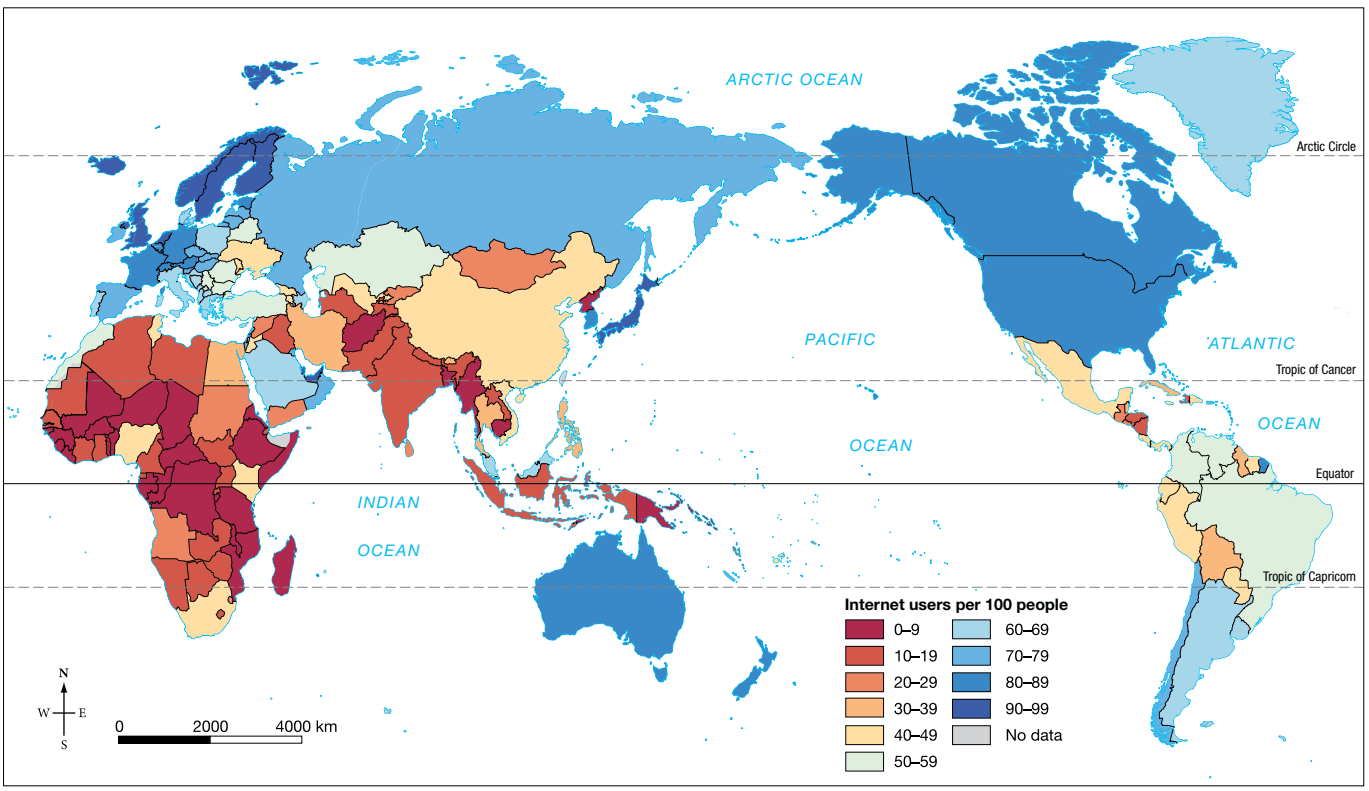
20.2.2 Internet access

Some of us take for granted the fact that we can access the internet almost everywhere we go, whether we are at home, school, at the shops, or even walking down the street. While this might not be the case for everyone in Australia, it is definitely not the case for everyone in the world (see figure 1).

20.2.3 ICT expenditure

It is important to note that the amount of money spent by individual countries on information and communication **infrastructure** can play a vital role in consumer access and uptake. Figure 3 indicates **expenditure** on information and communication technology (ICT) as a percentage of **gross domestic product (GDP)**. This map shows that expenditure across the globe is uneven and there is no set pattern. It is difficult to correlate access to ICT with country expenditure; for example, Australia

FIGURE 1 Internet users (per 100 people) in 2015



Source: Spatial Vision

spends between 3 and 6 per cent of its GDP, but access is relatively high. In contrast, a developing nation such as Bangladesh spends 9 to 12 per cent of its GDP, yet access is limited.

It is interesting to note that Estonia, a small country in Europe, sets a worldwide benchmark by providing free wireless internet access almost everywhere. A group of volunteers successfully lobbied Estonian cafés, hotels, hospitals, local governments and small business owners to provide this free access, which has been made available in a country with a GDP per capita of around $US 16 000; considerably lower than that of Australia, which has a GDP per capita of around $US 67 000. As a result, Estonian society has become reliant almost entirely on information in electronic form — doctors issue only electronic prescriptions, voting is conducted online, and government cabinet meetings are now paperless. Not only has free wifi helped the environment, it has also led to a better-educated society.

FIGURE 2 Mobile phone ownership by Australian state and territory

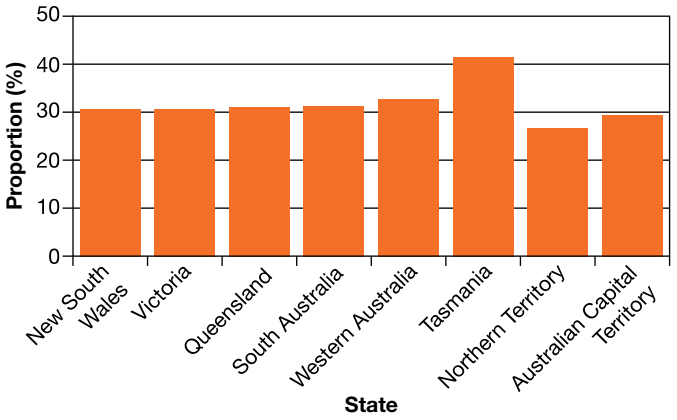
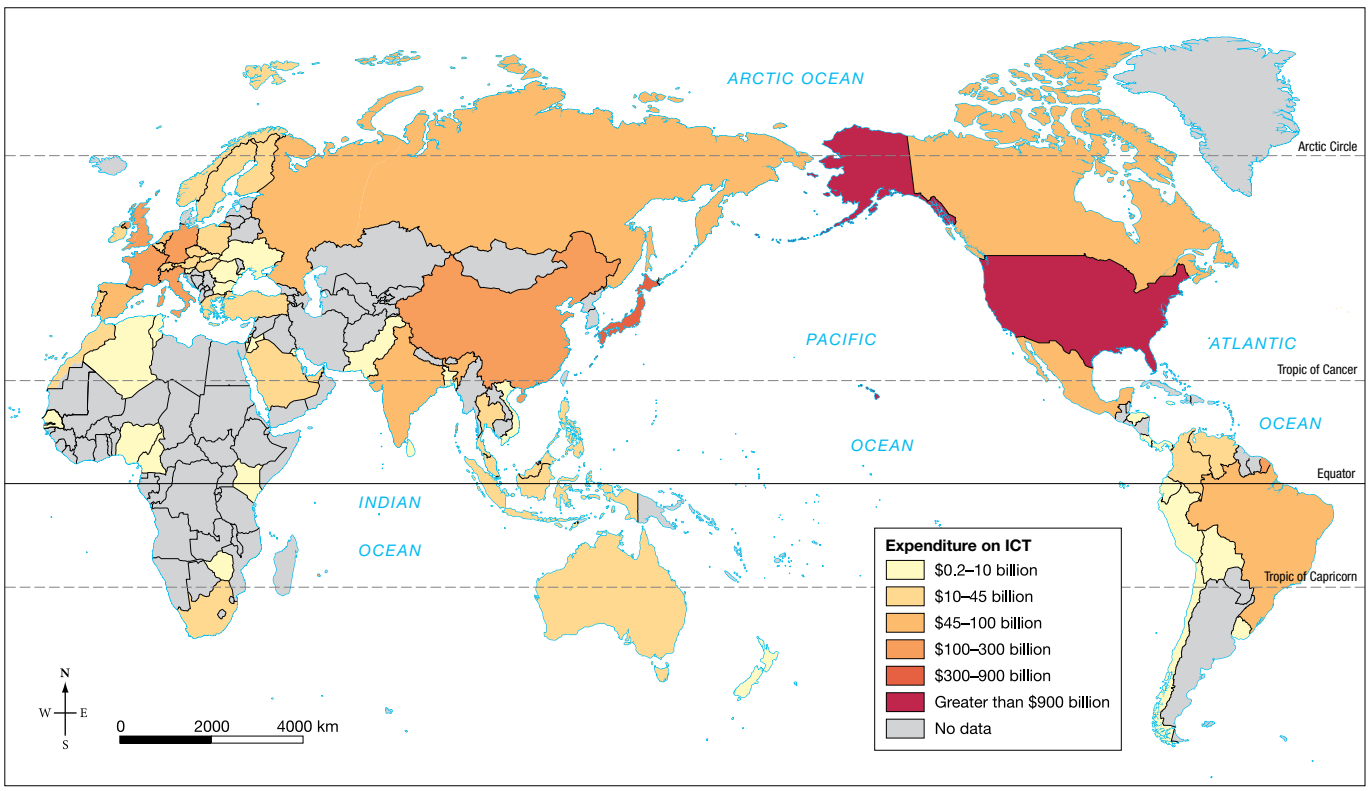


FIGURE 3 Expenditure on information and communication technologies by country, 2015



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 Refer to figure 2. Which state has the lowest percentage of mobile phone ownership?

INVESTIGATE

2 Research the reasons for Senegal and Morocco having a high expenditure on ICT.

3 Using figure 1 and the **Mobile phone subscriptions** weblink in your eBookPLUS, explain how global internet users and mobile phone subscribers are spatially ***interconnected***. What are the similarities and differences?

APPLY

4 Refer to figure 1. What factors do you think affect the pattern of internet use throughout the world?

PREDICT

5 Refer to figure 3. Where in the world do you predict there will be an increase in infrastructure expenditure in the next 10 years? Explain.

eBookplus

Weblink
Mobile phone subscriptions

eBookplus ONLINE ONLY

20.3 SkillBuilder: Constructing a table of data for a GIS

Why are there tables within GIS?

GIS, or geographical information systems, use tables to organise and store information about points, lines and polygons (vector data). These tables have rows and columns, called fields. The GIS software links the rows in the table to the points, lines or polygons on a map. Setting up the structure for a table helps us to understand how information may be stored digitally.

In a GIS, each row in the table is linked to a polygon on the map

Sample	Address	No_home	No_mobiles
1	42 Jacob Street	2	4
2	27 Jacob Street	3	3
3	36 Adele Avenue	4	3
4	34 Flint Street	4	1
5	35 Flint Street	5	3
6	25 Flint Street	4	2
7	12 Jess Court	4	2
8	2 Jess Court	4	4
9	12 Flint Street	5	3
10	52 Jacob Street	6	2

eLesson

Watch this video to learn how to construct a table of data for a GIS.



Searchlight ID: eles-1743

Interactivity

Try this interactivity to learn how to construct a table of data for a GIS.



Searchlight ID: int-3361

20.4 What are the consequences of unequal access?

20.4.1 What is the digital divide?

Unequal access to information technology creates a division between people with access and people without. Such divisions can have implications for economic growth and social equity. How often do you consider access to the internet as a necessity, not a luxury item?

digital divide a type of inequality between groups in their access to and knowledge of information and communication technology

There is a growth in internet access worldwide, but the gap between those able to access information technology and those who are not able to access information technology is widening. This is known as the **digital divide**. The divide is primarily based on internet access, but it includes all forms of information.

It is also evident within countries that some people have access to high-speed internet, while others only have access to dial-up internet.

Factors contributing to the digital divide are shown in figure 1.

The digital divide changes as the structure and characteristics of the population shift. Digital disadvantage is a dimension of poverty, which leaves people with a sense of powerlessness. If your ability to connect to information and communication technology is limited, this can affect what you are able to do with your life.

Globally, the average level of access to information and communications technologies (ICT) was 42 per cent in 2015. As figure 2 shows, the regions of South Asia (19 per cent) and the continent of Africa (26 per cent) have the lowest levels of connectivity. Internet access is only one aspect of the challenges faced by regions, as specific areas within a country may face disadvantage in terms of the factors displayed in figure 1. For example, regional areas of Australia may have difficulty accessing information technology. Nine out of ten people living in rural Africa don't have access to electricity. This unequal access may restrict the ability of communities to access information, communication and ideas that will enable them to overcome poverty and disadvantage.

FIGURE 1 A range of factors contribute to the digital divide.

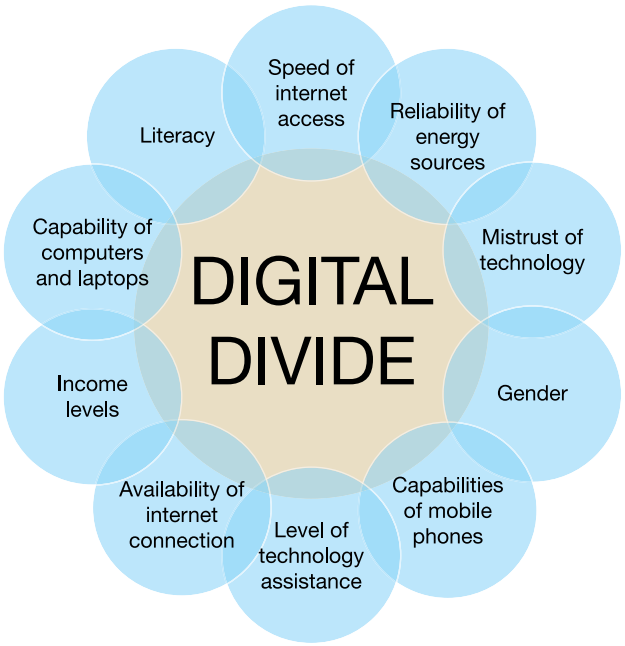
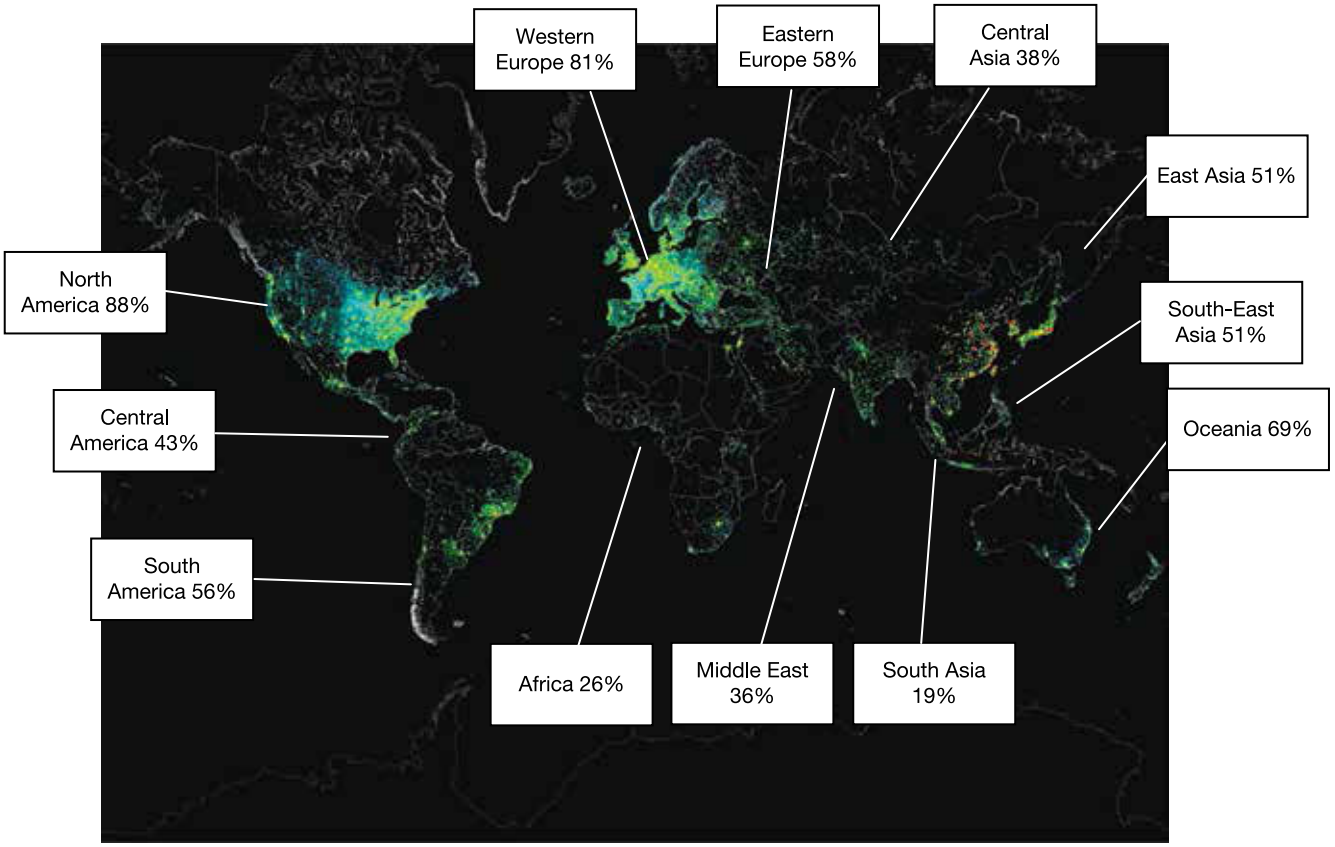


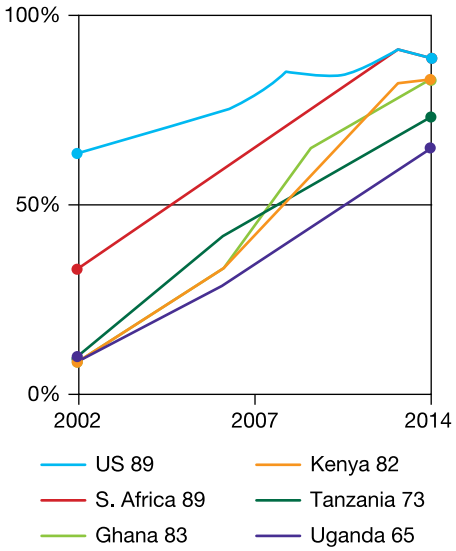
FIGURE 2 Regional differences in internet connection



20.4.2 Mobile phones and the internet

Mobile phone technology is transforming the way people are accessing ICT. Fewer people are subscribing to landline connections in favour of owning a mobile phone. Smartphone technology is allowing people to connect to mobile internet services and information. In Africa a large percentage of people (76 per cent) use mobile phones, but only a small percentage (7 per cent) are online.

FIGURE 3 Percentage of adults in the US and selected African countries who own a mobile phone



20.4.3 Sustainable Development Goals

United Nations Sustainable Development Goals were adopted in 2015 and support efforts to promote greater global connectivity. Improved global internet access is expected to provide the tools and knowledge needed to increase education and health opportunity, to create jobs, fight injustice and lift communities out of poverty.

Why bridging the gap is important

- *Economic equality*. Some social welfare services are administered electronically, so access to a telephone and the internet is important. The telephone also provides security, and can be used in emergency situations. In addition, access to the internet can be important for career development and accessing civic information.
- *Social mobility*. Computers play an important role in learning and education. The digital divide is unfair for children in lower socio-economic groups. The higher the qualification held by an individual, the more likely they are to have internet access at home.
- *Democracy.* Some people think that access to the internet creates a healthier democracy. It is thought that it increases public participation in elections and decision-making processes.
- *Economic growth.* Information and communication infrastructure and active use could stimulate economic growth, particularly for less developed nations. Economic changes and improvements tend to be associated with information technology. Certain industries can give a country's economy a competitive advantage.

FOCUS ON FIELDWORK

How connected are you right now?

At different times during our day, we are more connected to places, information and people than at other times.

1 Select three times of a day to review your level of connectivity; for instance, on the way to school, during your Geography class and then in the evening at home.
2 Record the level of connectivity at each time of the day by answering questions such as: What technologies am I relying on? Do I have internet access? Is it free? What internet access issues am I facing? Do I have a landline? What apps do I use to keep connected? What are the benefits of internet to my day?
3 Use your data to create a table and present this information as a graph that uses a different colour for each time of the day. What does the information display about your level of internet connectivity?
4 Were there any factors that may make this information unreliable? Why?



eBook*plus*

Interactivity
The digital divide
Use this interactivity to further your understanding of the extent and consequences of the digital divide.
Searchlight ID: int-3342

ACTIVITIES

IDENTIFY

1 Define the term *digital divide* in your own words.
2 Refer to figure 2. Using the statistics given, rank the internet connectivity of these regions from the most connected to the least connected.

EXPLAIN

3 Refer to figure 1. Describe how any three of the factors shown contribute to a digital divide.
4 Refer to figure 3. Compare the level of mobile phone ownership for the US with that of one of the African countries listed over the period 2002 to 2014.

INVESTIGATE

5 Refer to figure 2. Research the names of the countries found in South Asia. How do you account for low connectivity levels in these countries?
6 Propose an initiative to improve the level of connectivity currently found in one community. What challenges need to be overcome? What change will it introduce to the community?

20.5 How has technology improved lives in developing countries?

20.5.1 The situation in Kenya

While there is a difference between the developed and developing world, it is important to note that access to the internet and mobile phone networks is improving. This is largely thanks to non-government agencies and to service providers. The people of Kenya, for example, no longer need to take long journeys into town or to wait in long queues just to transfer money. Instead, they can type in a couple of numbers, hit a button, and pay for anything they want within seconds via mobile phone.

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

Most people in Kenya live in rural and remote places in the countryside. Landline access is very limited, and it is also considered costly to install, owing to the vast distances. This can leave families disconnected from one another, as the primary earner in the family often has to work in a distant township in order to provide money for the family. Those left in the rural villages are often self-employed farmers or tradespeople. Without communication, families are often disconnected.

Improving access

Mobile phone coverage and access has been significantly improved in Kenya, which has dramatically improved people's lives. The UK-based **non-government organisation (NGO)** called Financial Deepening Challenge Fund (FDCF) has worked with Vodafone to set up M-Pesa, meaning 'mobile money'. A customer can go to an M-Pesa agent, such as a supermarket, and:

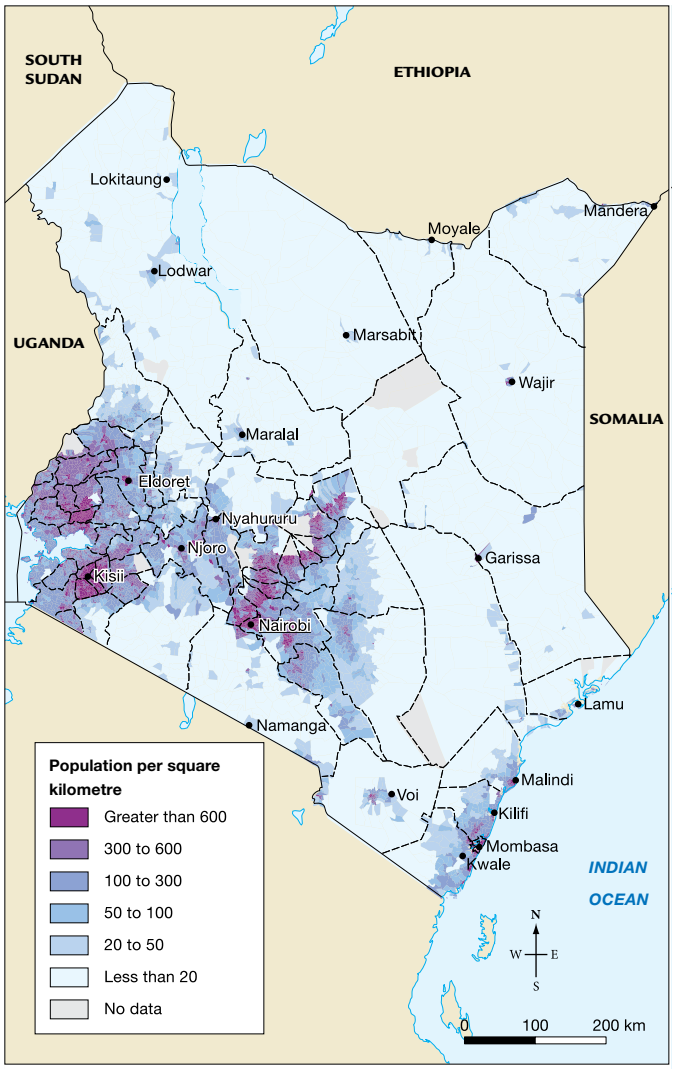
- deposit and withdraw money
- transfer money to other users and non-users
- pay bills
- purchase phone credit
- transfer money between the service and a bank account (see figure 1).

People do not need a bank account or even a permanent address to use M-Pesa. They receive a text message to confirm a transaction, and the money can then be stored on the phone or it can be forwarded to someone else. At any time, the money can be transferred back to cash through an M-Pesa agent or an ATM. Figures 2 and 3 show mobile phone coverage and population, indicating the coverage is significant in highly populated areas.

FIGURE 1 Customers at an M-Pesa agent in Kenya

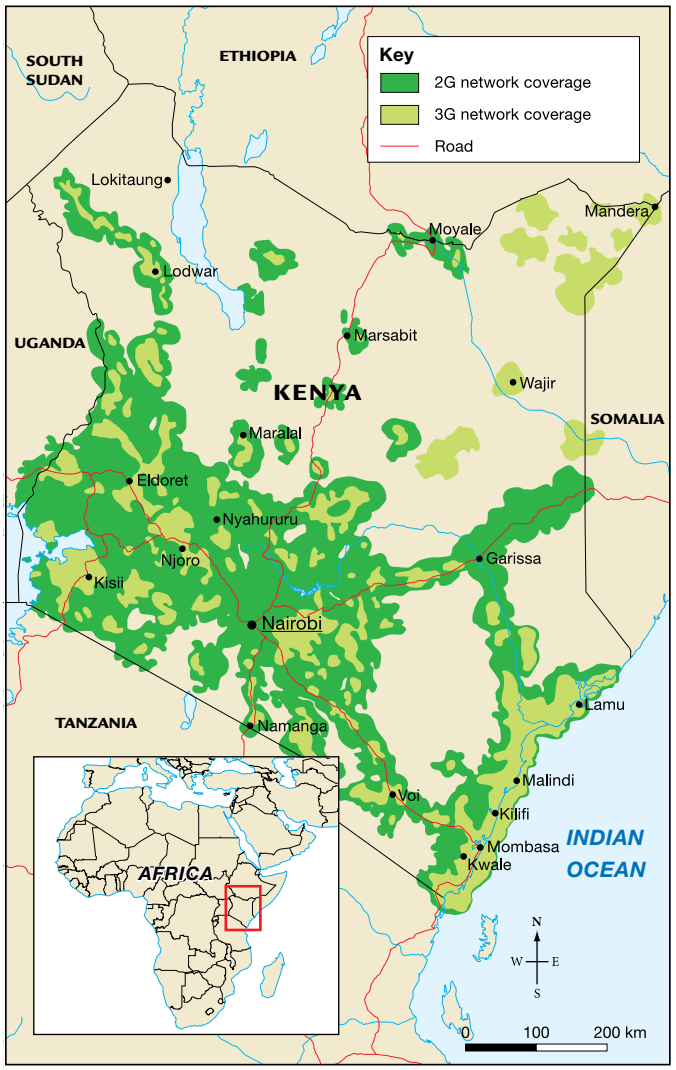


FIGURE 2 Kenya, population density



Source: Spatial Vision

FIGURE 3 Kenya, mobile phone coverage



Source: Safaricom

FIGURE 4 A local market in Kenya



How successful has it been?

Today there are around 25 million subscribers and over 40 000 M-Pesa agents in Kenya. These agents include petrol stations, supermarkets and other retail outlets. By 2014, over 70 per cent of Kenya's population was using M-Pesa.

Taxi drivers have benefited, too. They no longer need to drive around with a lot of cash in their cars, because their passengers are able to pay using M-Pesa. It has also been seen as an improvement in personal safety, because it is a secure and easy way to transfer money.

Access to mobile phones for small business operators has meant they are now able to advertise to a larger audience, and are no longer dependent on word-of-mouth advertising. Clients can now contact business operators with ease. For those working away from home, it is a safe and easy way to send

money back to families in the countryside. This has enabled **Maasai** herdsmen to go to the markets and make purchases by using their mobile phones. M-Pesa has eliminated the need to carry large sums of cash to markets, and has reduced the number of thefts.

M-Pesa demonstrates how dreaming big but thinking locally can have a significant effect on the economic and social structure of a place, just through the use of a mobile phone.

Maasai ethnic group of semi-nomadic people in Kenya and Tanzania, whose way of life depends on their cattle

ACTIVITIES

IDENTIFY

1 How successful has M-Pesa been in Kenya? Ensure you use specific examples in your answer.
2 What ***interconnections*** can now occur between people because of M-Pesa?

EXPLAIN

3 Why would safety be a concern to people in Kenya? How does safety relate to information and communication technology in Kenya?
4 What ***places*** in Kenya are well serviced by the mobile phone network?
5 Which ***places*** are not well serviced by the mobile phone network? Suggest reasons for this.

APPLY

6 Using the internet, research how another developing country has improved its information and communication technology. Create a multi-modal presentation on your findings.

INVESTIGATE

7 What services in Australia serve a similar purpose to M-Pesa? Explain what they are and how they operate.

20.6 How has technology improved in Australia?

20.6.1 The digital economy

In a bid to make internet access faster and more accessible in Australia, the federal government is developing the National Broadband Network (NBN). This revolution in Australia's infrastructure aims to connect more people, in an affordable way. It is yet to reach all homes in Australia but, when it does, it will vastly improve the digital economy.

When you use your debit card to buy a movie ticket, send a text to a friend on your mobile, or use a web browser to check your phone balance, you are participating in the **digital economy**. Participation in this economy can improve productivity, social wellbeing and competitiveness. In addition, it has the potential to improve access to services such as education, and to improve environmental, health and social outcomes in rural and regional Australia.

digital economy the network of economic and social activities that are supported by information and communication technology, such as the internet and mobile and sensor networks

20.6.2 What is the NBN?

The NBN is the infrastructure that will improve and enlarge Australia's digital economy in the future. It is a revolution in telecommunication technology, involving three main technologies: fibre optic cable, fixed wireless and satellite (see figure 2).

The plan is to ensure that all Australians can connect to this new high-speed broadband network (see table 1).

TABLE 1 Future NBN access in Australia

Who?	How much?	Access via	Speed
Homes, school and businesses	93%	Fibre optic	1 gigabit per second
Premises	7%	Fixed wireless and satellite	12 megabits per second

20.6.3 How does Australia compare?

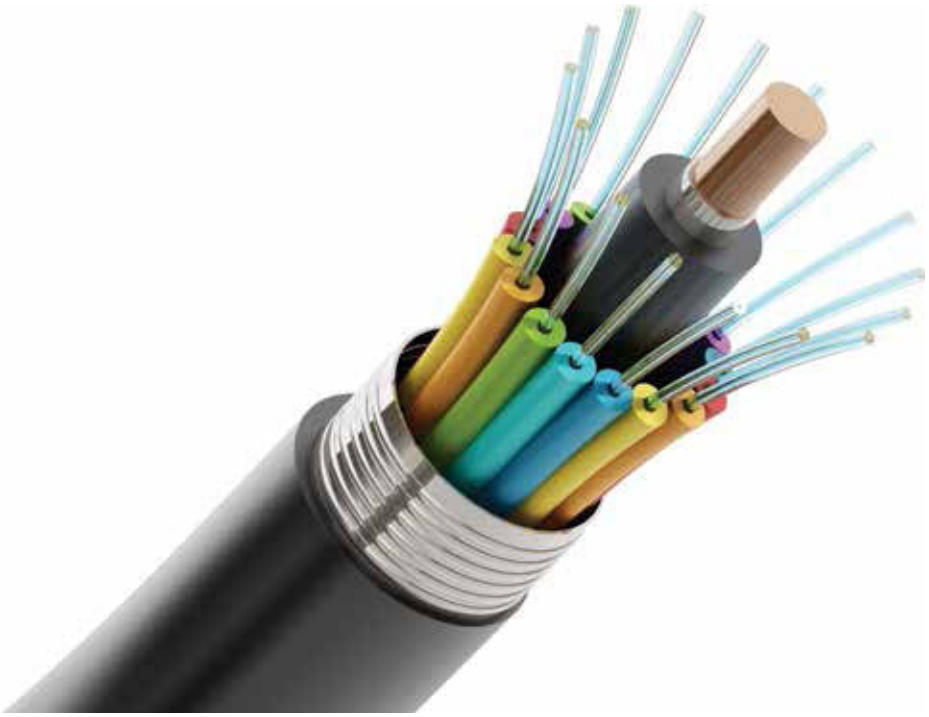
OECD Organisation for Economic Co-operation and Development, which has 34 member countries and promotes policies that improve economic and social wellbeing

In terms of broadband infrastructure, Australia was falling behind the 34 **OECD** countries, so it was felt that action needed to be taken. It was also noted, in 2015, that Australia is one of the most expensive countries for broadband.

Rural and remote communities

Data indicate that the number of people who have never used the internet in Australia is highest in rural and remote communities. For example, between 2008 and 2009, 23 per cent of people living in major cities who were over the age of 15 did not use the internet. In comparison, 31 per cent of people in regional and remote Australia did not use the internet. It is also noted that, of all businesses located outside capital cities, only 29.7 per cent had a web presence, while 39.5 per cent of capital city businesses did. Therefore, the government regards it as a priority to roll out the NBN in rural and remote communities in order to ensure greater involvement in the digital economy.

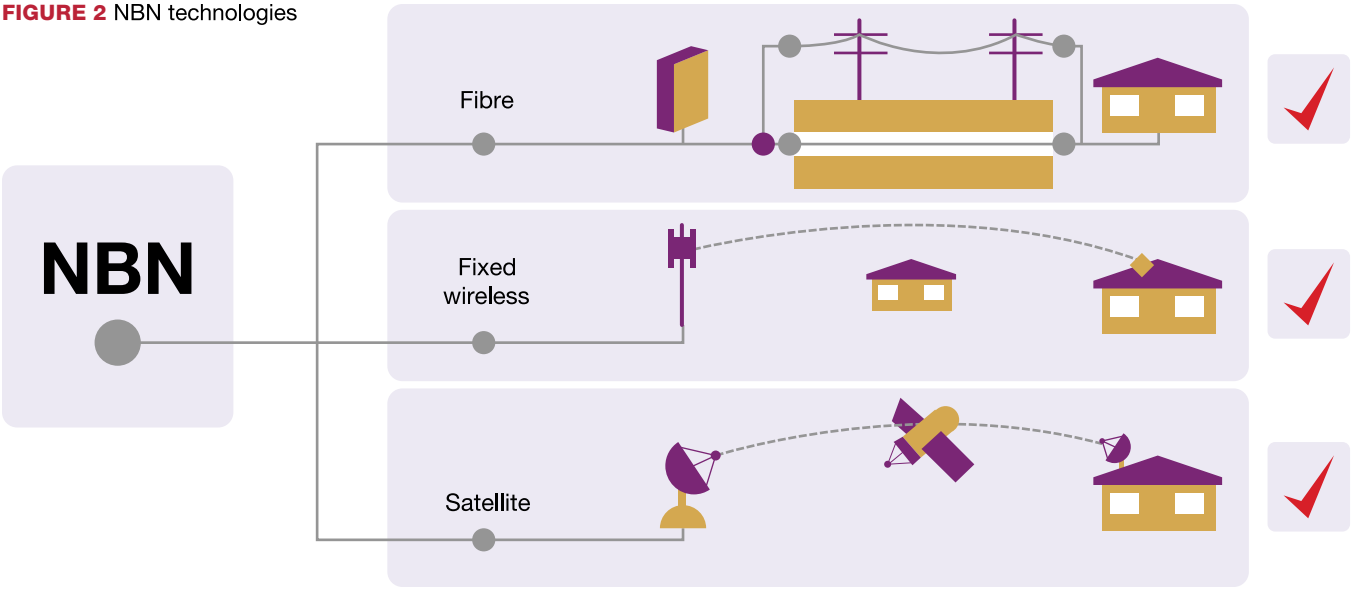
FIGURE 1 Fibre optic cable



20.6.4 Opportunities of the NBN

- *Business.* Using applications and services that rely on the NBN will improve efficiencies and reduce costs. The NBN could result in an expansion of markets, through greater interconnections in Australia and overseas. Businesses will have more choice of location, particularly in rural and remote places. It could also improve efficiency, and may reduce the need for a physical presence. Improvements in infrastructure will lead to improved technologies, such as videoconferencing, allowing healthcare, for example, to reach remote Australia and promote the sharing of knowledge.
- *Education.* Distance between student and teacher will no longer prevent access to specialist teachers across Australia. It will improve collaborative learning practices between schools and higher education facilities, and promote the international exchange of ideas. In addition, the NBN will improve access to online learning and collaboration beyond the walls of the classroom.
- *Environment.* Access to digital technology has demanded new ways of managing household consumption of resources. Smart energy grids can be installed to manage energy consumption, and changes can be made during peak energy demands. Farming systems can be improved by technologies that are accessible with the NBN, such as measuring soil moisture in relation to weather conditions.

FIGURE 2 NBN technologies



20.6.5 When will I get the NBN?

The NBN is being rolled out over the next few years, with the latest phase expected to be completed by mid 2020 connecting 4.9 million homes and businesses. Each year a new plan will be released, indicating the targeted areas. Once an area has been declared NBN-ready, it can take up to three or four weeks for providers to be able to supply customers with a connection.

20.6.6 Downloads

Most of us are familiar with exceeding our download limit; we never feel we have enough. The average volume of downloaded data per Australian subscriber is 58 GB per month. This is a significant increase from an average of less than 6 GB per month per household in 2006. In 2013, the average download volume for a household connected to the NBN was 46 GB per month, indicating that connection to the NBN is resulting in an increase in data downloads. It is predicted that data consumption is set to increase up to four-fold in the next five years as the roll-out of the NBN continues.



FIGURE 3 The Sky Muster satellite was launched in 2015 to improve connectivity for remote Australia.

Recent trends show video and app-based mobile use is dominating data traffic. In 2014, video accounted for 45 per cent of all mobile data traffic. It is expected that, by 2020, video will account for 60 per cent of data traffic, as video streaming companies enter the Australian market.

ACTIVITIES

IDENTIFY

1 What is the digital economy?
2 What are the three forms of NBN technologies?

EXPLAIN

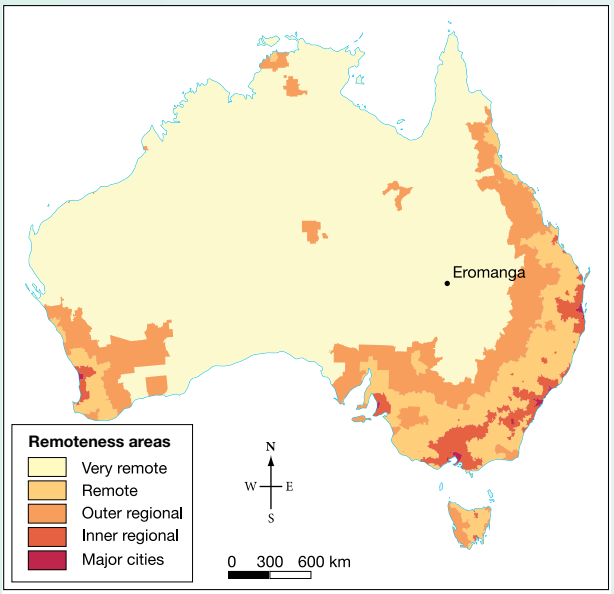
3 Why is it crucial that Australia builds the NBN?

APPLY

4 Using the **NBN** weblink in your eBookPLUS, describe the geographical pattern of the NBN and the types of technologies that are being used in different regions.

INVESTIGATE

5 Imagine what life would be like without the internet and mobile phones. Write a letter to a friend about your life without such technology.
6 Imagine this scenario. You have just been selected to 'live remotely' for two weeks with a partner of your choice in the remote Queensland town of Eromanga. Use the **Connect** weblink in your eBookPLUS to justify your choice of phone company to provide the best connectivity for you during your stay.



Source: Spatial Vision

eBookplus

Weblinks
- NBN
- Connect

20.7 How are e-wastes managed?

20.7.1 What is e-waste?

Litter in the schoolyard is only minor waste compared with that produced by technology and communication: **e-waste**. A controversial issue is how to dispose of it. The disposal and trade of e-waste is seen by developed nations as a solution and by many developing countries as a money maker. How e-waste is dealt with has serious economic, environmental and social consequences.

e-waste any old electrical equipment that includes computers, toasters, mobile phones and iPods that no longer work or are no longer required

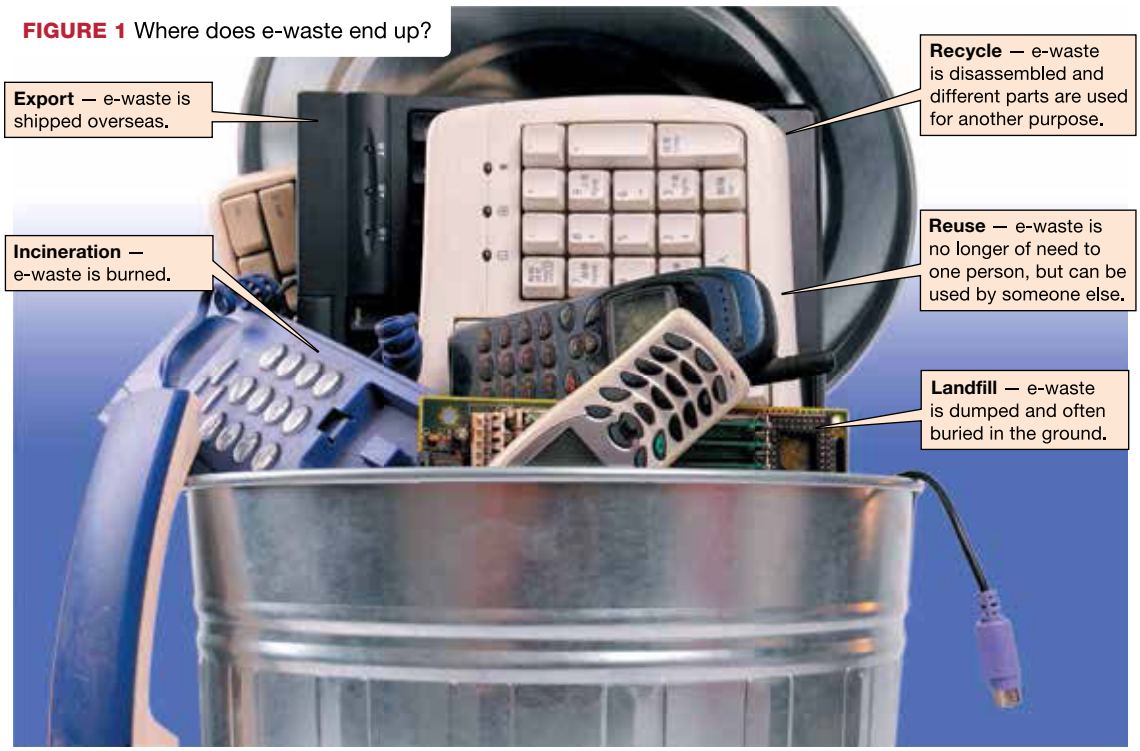
e-waste is any old electrical equipment, such as computers, toasters, mobile phones, iPods and televisions that are broken, obsolete or no longer wanted. Given our technology-based lifestyle, our e-waste pile is growing at an alarming rate — faster than we know what to do with. There are five main places where e-waste usually ends up (see figure 1).

20.7.2 What are the impacts of e-waste?

Many of us do not think about where our rubbish goes. We just put it in a bin, and then it is out of sight, out of mind. However, e-waste is now a part of the global economy, and is sold, shipped and dumped worldwide.

Nevertheless, we must think about the ramifications of such actions. Computers are made up of many toxic chemicals and metals; when dumped, these can cause significant environmental and health problems (see figure 3).

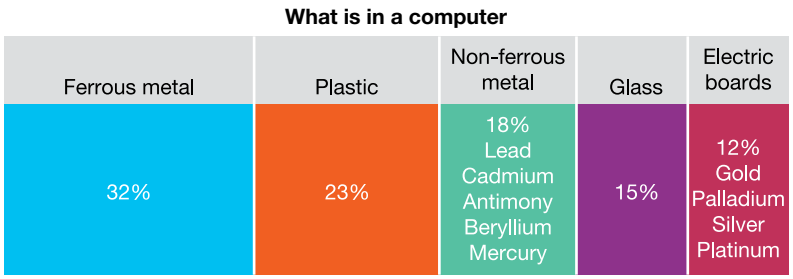
FIGURE 1 Where does e-waste end up?



Health impacts

In the slums of Delhi, computers, keyboards and monitors are pulled to pieces and then placed in acid baths or melted, to extract metals. This practice should only ever occur in proper recycling facilities, where safety precautions can take place. Consequently, there has been a rise in Delhi in **mercury poisoning** and other side effects of dealing with cadmium, plastic, PVC, barium, beryllium, and carcinogens such as carbon black and heavy metals (see figure 2).

FIGURE 2 Composition of a computer



A report by India's Department of Scientific and Industrial Research showed that e-waste being sent to India is increasing by 10 per cent each year. Slum dwellers are unsafely disassembling the e-waste, and toxins are damaging the health of an enormous number of people.

Exposure to mercury, even in tiny amounts, can lead to health problems and threaten child development. It damages the nervous, digestive and immune systems, and harms the lungs and kidneys. It is corrosive to the eyes and skin and to the gastrointestinal tract if swallowed. Neurological and behavioural disorders have also been observed, which can lead to insomnia, memory loss and motor dysfunction. A large number of women and children in India now expose themselves daily to mercury while working in makeshift e-waste recycling facilities in slums.

mercury poisoning a toxic condition caused by the ingestion or inhalation of mercury or a mercury compound. It has various symptoms, including vomiting, nausea, insomnia and fevers.

Environmental impacts

As we have seen, thousands of tonnes of e-waste are being dumped in developing countries. There, the e-waste is burned in informal recycling stations in slums. In the slums, there is nowhere to dispose of byproducts such as acid and cyanide, and they are simply dumped in the local waterways or onto the soil. This contaminates aquifers and destroys vital freshwater resources, making the land too toxic to farm.

eBook*plus*

Interactivity
e-wasted
Use this interactivity to further your understanding of the impacts of e-waste.
Searchlight ID: int-3343

The issue is that the e-waste can be of great value to the citizens of developing nations, such as China and India, because it is a fairly easy way to make money. However, the chemical composition of products such as mobile phones leaves a deadly trace in the environment.

The burning of plastic leads to an increase in air pollution, resulting in above-standard emissions. The air is often left with the stench of acid, paint and plastic, which impairs people's quality of life. Contamination of agricultural soils may occur, affecting local farms, which are often the main form of income in developing countries.

Waste acids recovered from the burning process, which are of no value or use, are often dumped in rivers and streams, damaging the ecosystem. Often this leaves waterways black and pungent, and leads to contamination of drinking water. In Guiyu, China, the water is so toxic it can disintegrate a coin within a few hours.

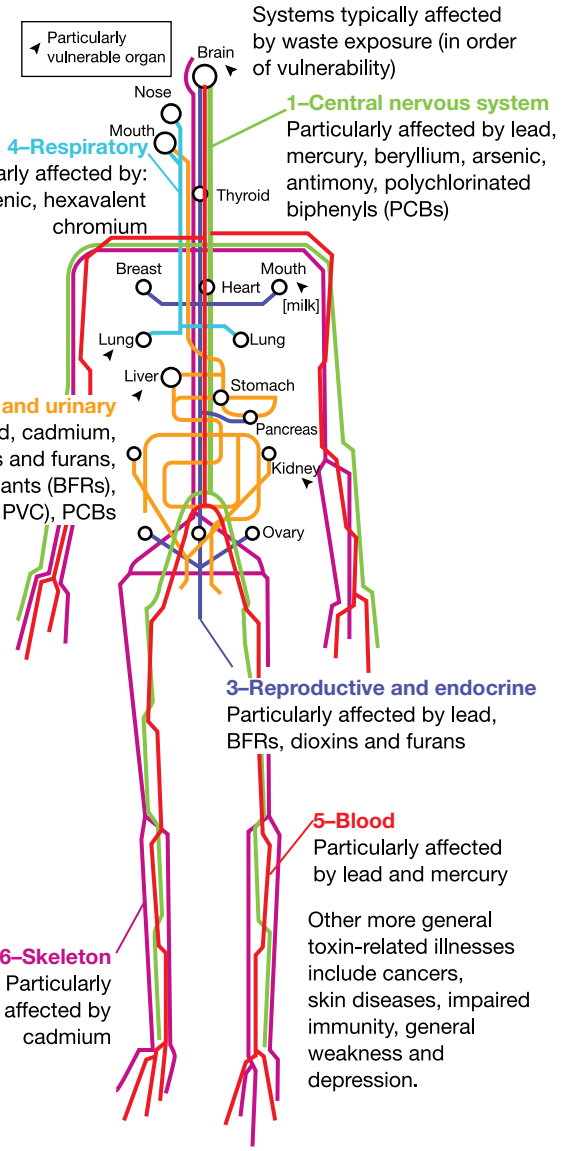


FIGURE 3 Health impacts of e-waste on waste workers and people who live near landfills or incinerators

20.7.3 International management of e-waste

By the start of this century, many countries could not deal with either the quantity or toxicity of the e-waste they were generating. One solution was to export it to developing nations that did not have laws in place to protect workers or the environment. It is also significantly cheaper to recycle waste in developing nations.

Concerns in Europe regarding the export of e-waste led to the Basel Convention in 1989. This was adopted by the European Community in 1994, which banned the exports of hazardous waste to countries other than OECD countries, which were mostly developed countries. Waste had to be collected and recycled according to European Union (EU) environmental standards. The EU has reluctantly admitted that its rules are only somewhat effective, as bans on exporting e-waste are being ignored or avoided. Scrapyards in Asia are able to extract valuable substances from the waste.

Rotterdam is Europe's busiest port, with more than nine million shipping containers passing through each year. Despite every effort, only three per cent of all containers in Rotterdam are checked; consequently only about one illegal shipment of e-waste is caught each week. Inevitably, containers of e-waste slip through. One of the difficulties that customs officers face is the fact that it is not illegal to export goods to be re-used and sold as secondhand goods.

The United Kingdom's Environment Agency, which is in charge of regulating hazardous waste in England and Wales, has set up international cooperation and intelligence with over 40 countries. This is being done in order to combat the illegal smuggling of e-waste, and companies are fined if they are caught. The United States has not ratified the Basel Convention, and they are seen as lagging behind Europe. Almost 80 per cent of their e-waste goes to China via Hong Kong (see figure 5).

FIGURE 4 Goats being herded through e-waste smoke around the Agbogbloshie dump in Ghana. When e-waste ends up in landfill, the toxins, carcinogens and heavy metals in it can leach into the environment. These substances then contaminate the groundwater and soil and enter the food chain.



Until we find a cheap alternative to dumping waste overseas, it is going to be difficult to compete with this process in developed countries. More research needs to be done on how to make recycling safer in developing countries, and how to enable it to take place in proper factories instead of unsafe makeshift plants.

20.7.4 Local e-waste management

According to the Australian Bureau of Statistics, almost all Australian households were involved in some form of recycling in the last 12 months. However, in 2009, nearly a quarter of electronic equipment and half of household appliances were placed with non-recycling garbage.

Locally, most waste transfer stations in metropolitan areas now have e-waste facilities. A visit to the tip is no longer a matter of putting everything into landfill; it involves a more complex system of organisation. On arrival at your local waste transfer station, you are directed to various stations to dispose of your waste. Such stations include green waste, white goods, oils, gas bottles, petrol cans, copper and e-waste. This sorting of waste not only reduces the need for landfill, but also encourages and enables more recycling to take place.

FIGURE 5 Who gets the trash?



Source: Spatial Vision

FIGURE 6 e-waste facility at a refuse station



ACTIVITIES

IDENTIFY

1 Define the term *e-waste*. Compile a list of potential e-waste either in the classroom or in your home.

2 Why is it difficult to prevent the illegal trade in e-waste?

EXPLAIN

3 Using figure 5, explain the geographical pattern to illegal dumping of e-waste. Ensure you make specific reference to ***places*** in Asia on the map.

APPLY

4 Discover the difference between ferrous and non-ferrous metals. Which is more harmful to humans and the ***environment***?

5 Research the metals listed in figure 3, and explain what makes them harmful to humans and what ***environmental*** effects they can have.

INVESTIGATE

6 Create a presentation on how e-waste is managed at your school. Suggest strategies for making the current management techniques more ***sustainable***.

7 Why are international agreements on e-waste difficult to manage?

eBook*plus* ONLINE ONLY

20.8 How does e-cycling work?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

20.9 How can you reduce your consumption?

20.9.1 Recycling your e-waste

On a global scale, entrepreneurs are tackling the waste problem society is creating. We live in a part of the world where consumption of information and communication technology is high. However, some global solutions have now been set up to ensure that individuals can easily find out online about what is recyclable, and can then undertake recycling from their own home. Society is now being encouraged to act locally, while thinking globally. This is an important concept when it comes to reducing and managing one's own consumption.

Electronic waste, or e-waste, is defined as any device with a cord or a battery. An estimated 16 per cent of global e-waste is being recycled and reused.

According to the Australian Bureau of Statistics (ABS), when people were surveyed about their e-waste disposal, most stated that they did not recycle because they did not generate enough materials to warrant the use of e-waste services or facilities. Perhaps if everyone knew more about the hazardous nature and environmental impacts of e-waste, the idea of recycling would be embraced.

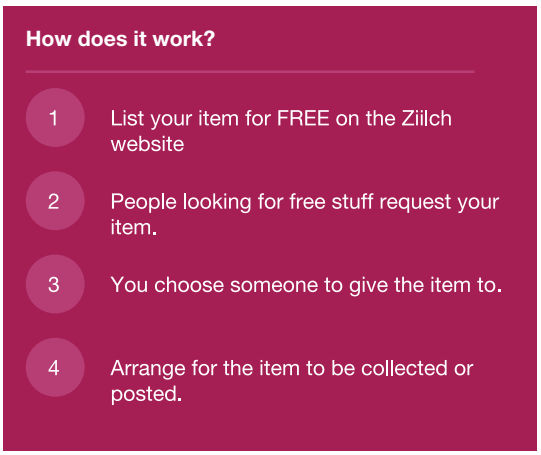
Below are some innovative ways of dealing with waste.

Ziilch

Most of us have an old computer we no longer use, or an old charger for a device we no longer have. We may even have books, furniture or clothing that could be recycled. The website Ziilch has come up with an easy solution to de-clutter, find new items and save on disposal costs. It is as easy as a click of a button (see figure 1).

This online company connects people in different places, and the platform enables you to exchange goods for free. This promotes the idea of recycling, which reduces consumption and hopefully leads to a more sustainable future.

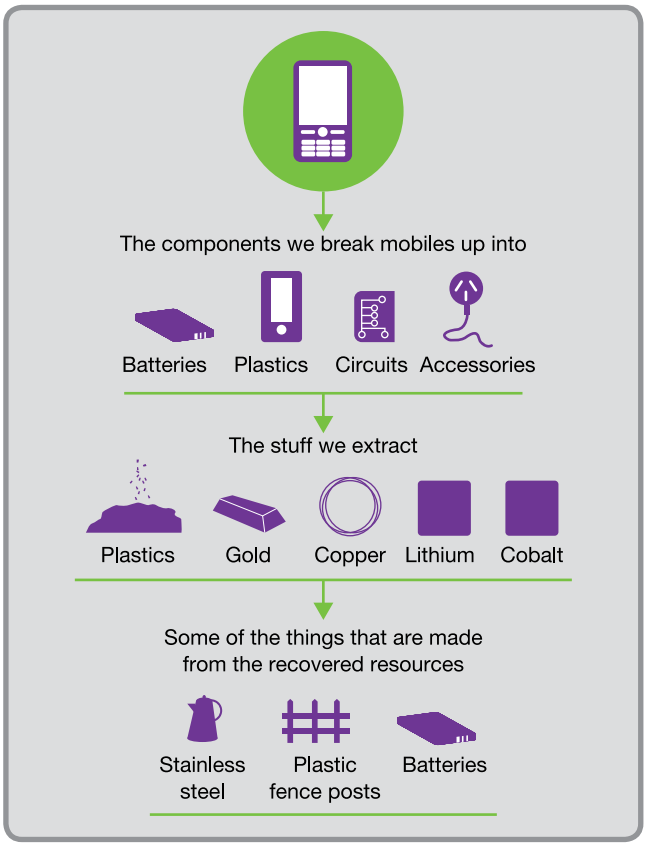
FIGURE 1 How Ziilch works



MobileMuster

MobileMuster is a simple, easy way to dispose of old mobile phones, batteries and accessories. MobileMuster is voluntarily funded and managed by distributors, network carriers, service providers and manufacturers. It is a free service where you can send your mobile phone or find your nearest drop-off point, of which there are over 4500 in Australia. This ensures that mobiles are recycled correctly rather than dumped in **landfill**. Over 90 per cent of materials in mobile phones can be recycled (see figure 2).

FIGURE 2 The mobile phone recycling process



landfill a method of solid-waste disposal, in which refuse is buried between layers of soil

By using a certified recycling program, you can ensure that your e-waste is not being illegally exported, and the environment is not being contaminated by the metals and minerals in the products.

carbon emissions carbon dioxide that is released into the atmosphere by natural processes or by burning gas, coal or oil, for example; the latter emissions are contributing to climate change

Reduce energy consumption

It is not only important to be involved in recycling, but also vital to reduce your **carbon emissions**, which is another byproduct of information and communication technology. Some strategies include:

- turning off your PC overnight, on weekends and during holiday periods
- ensuring printers and other equipment are switched off when not in use
- refraining from printing emails whenever possible
- removing active screensavers
- only charging your mobile phone when it is flat.

FIGURE 3 A local council advertising e-waste collection



National Television and Computer Recycling Scheme

The National Television and Computer Recycling Scheme will provide households and small businesses with free recycling services for televisions and computers. While it is governed by Commonwealth legislation, *Product Stewardship Act 2011*, state and territory governments retain responsibility for regulating waste.

The scheme commenced in 2011 and has been able to provide residents with a more coordinated approach to local e-waste disposal. The first drop-off points were rolled out in 2012 in metropolitan areas, and expanded into rural and remote areas in 2013. The scheme will accept all televisions, computers, and computer accessories such as keyboards and hard drives.

It is hoped that by 2021–22, recycling of computers and televisions will have reached 80 per cent, compared to the 17 per cent that are recycled today.

FIGURE 4 Electronic devices and accessories are collected for recycling by local councils.



FOCUS ON FIELDWORK

Conducting a class survey

In a group, conduct a class survey in which you interview students and teachers about their recycling habits.

Decide on the types of questions you wish to ask and how you will record responses. If you wish to do this online, use the **Survey Monkey** weblink in your eBookPLUS.

After you have conducted your surveys, collate and present your findings in graphic form.

Analyse your graphs and write a summary of your findings, ensuring you cover the following questions.

- Are students more environmentally conscious than teachers?
- Does age make a difference?

Prepare a recycling plan for your school.

eBook*plus*

Weblink
Survey Monkey

ACTIVITIES

IDENTIFY

1 a What do you understand by the term *e-waste*?

b According to the ABS, what is the main excuse that people give for not recycling?

2 Refer to figure 2. Name three byproducts extracted from mobile phones and two products that can be made from recovered resources in mobile phones.

APPLY

3 Have you ever participated in a national or global recycling scheme? If so, explain what it was and what you recycled. If not, suggest what you could recycle and how to do so.

4 Create a mind map to display the things you can do daily to reduce your energy consumption.

INVESTIGATE

5 Find out where your nearest National Television and Computer Recycling Scheme drop-off point is. Describe this ***place*** in relation to where you live. Is it realistic for you to take your recyclables there?

20.10 Can waste be managed more sustainably?

20.10.1 Woodlawn Eco Precinct

Woodlawn Eco Precinct is a former mine site being used as a waste management facility. The waste management facility is located near the settlement of Tarago, New South Wales, 250 kilometres south of Sydney. Here, compost is created from containerised organic and household waste that is delivered to the site by freight train and trucks. The compost is used as landfill to rehabilitate the former open-cut mine site shown in figure 1.

More recently, bioreactors are being used to extract organic matter from waste. Sustainable technologies such as wind farms generate enough energy to power over 4000 homes. Fish farming and horticulture are also being practised at the site. Figure 3 shows the movement of the waste between Sydney and the tip.

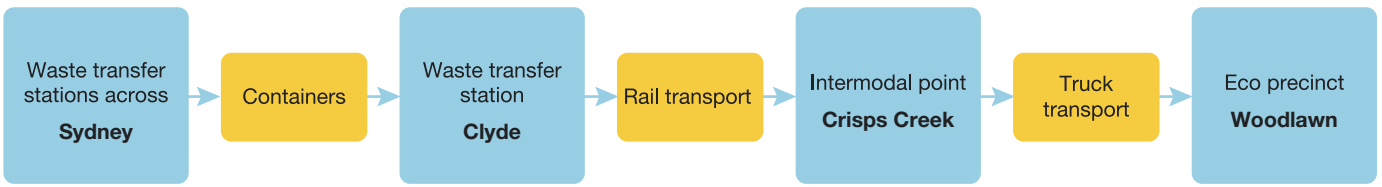
FIGURE 1 Former mine site at Tarago, New South Wales



FIGURE 2 Rubbish from Sydney is being transported to Woodlawn.



FIGURE 3 Many forms of transport are used to move 20 per cent of Sydney's waste to Woodlawn.



ACTIVITIES

IDENTIFY

1. Give the location of the Woodlawn mine open pit using at least two area references (AR).
2. What is the direction of Tarago railway station from the Woodland open-cut mine?
3. Using the scale of the map, calculate the width of the Woodlawn open-cut mine.
4. Suggest the direction of water flow in Crisps Creek.

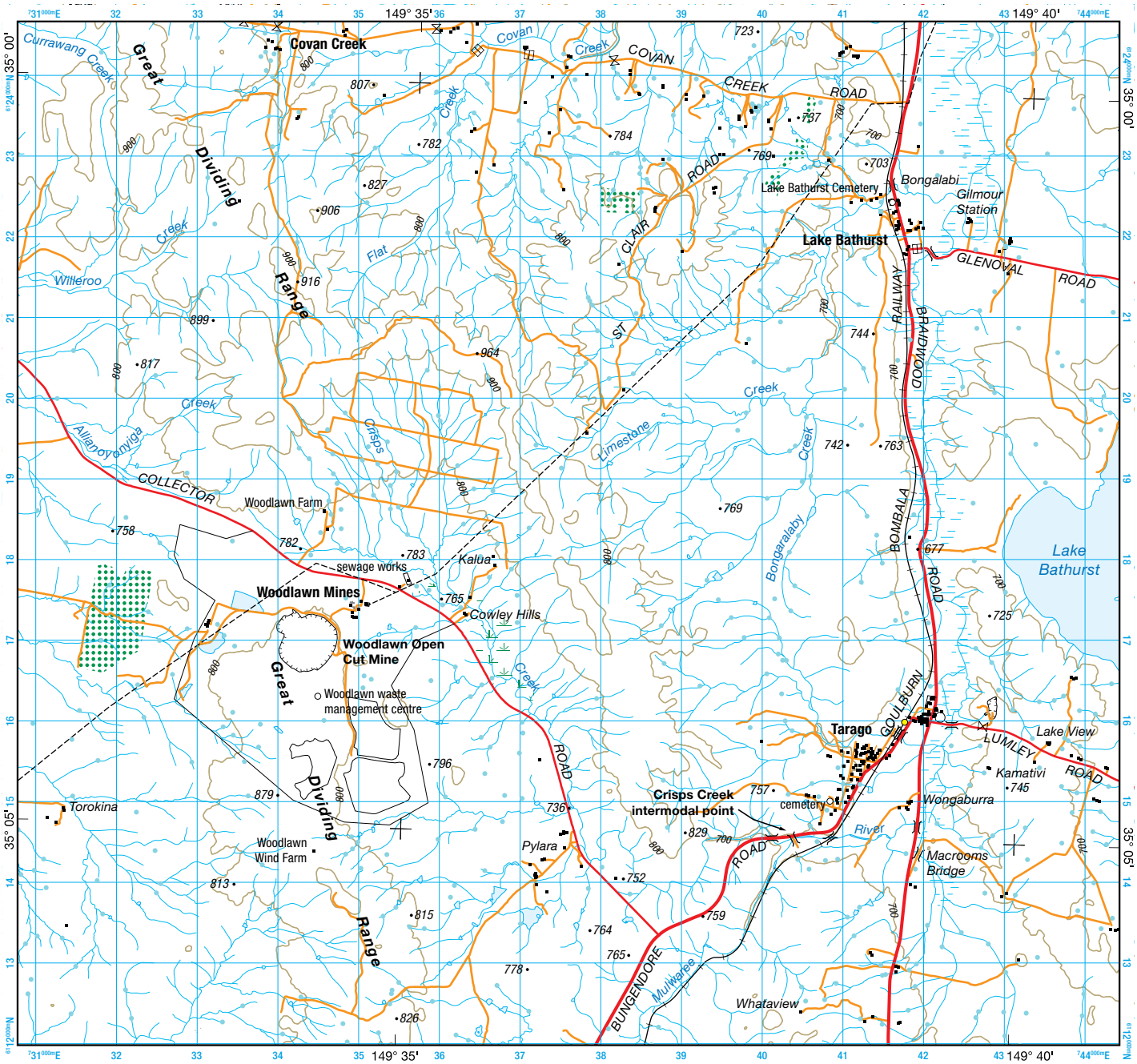
APPLY

5. Use the **Woodlawn MBT Facility** weblink in your eBookPLUS to find out more about the Woodlawn mechanical biological treatment operations.
6. Examine the topographic map of Woodlawn in figure 4 and suggest reasons why this site was chosen as a waste dump.
7. Use evidence from the map (for example, AR or GR) to suggest two environmental problems that could occur at this site, if it is poorly managed.
8. Woodlawn waste management facility is using aquaculture, wind farming and agricultural practices at the Tarago site. Using AR and GR locations, suggest an appropriate location for each of these activities. Give reasons for your answer.

eBookplus

Weblink
Woodlawn MBT Facility

FIGURE 4 Topographic map of Woodlawn



Key

- Water area
- Swamp - wet
- Land subject to inundation
- Orchard or plantation
- Open-cut mine
- Land use boundary
- Watercourse or canal
- Contour with height (metres)
- Spot height (metres)
- Building point
- Water point
- Landmark point
- Highway sealed
- Secondary road sealed
- Minor road unsealed
- Railway; railway station
- Transmission line
- Cattle grid
- Gate
- Bridge

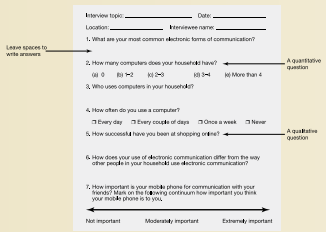
Source: Land and Property Information, NSW.

eBookplus ONLINE ONLY

20.11 SkillBuilder: Using advanced survey techniques — interviews

What are interviews that survey people's opinions?

Conducting a survey means asking questions, recording and collecting responses, and collating the number of responses. Interviews are particularly useful for gathering information on attitudes and values. An interview, which is an advanced survey technique, allows you to explore attitudes and values without being restricted by survey categories.


Interview topic: _____ Date: _____

Location: _____ Interviewee name: _____

1. What are your most common electronic forms of communication?

Leave spaces to write answers

2. How many computers does your household have? ← A quantitative question

(a) 0 (b) 1–2 (c) 2–3 (d) 3–4 (e) More than 4

3. Who uses computers in your household?

4. How often do you use a computer?

❒ Every day ❒ Every couple of days ❒ Once a week ❒ Never

5. How successful have you been at shopping online? ← A qualitative question

6. How does your use of electronic communication differ from the way other people in your household use electronic communication?

7. How important is your mobile phone for communication with your friends? Mark on the following continuum how important you think your mobile phone is to you.

Not important Moderately important Extremely important

eLesson

Watch this video to learn how to use advanced survey techniques.



Searchlight ID: eles-1742

Interactivity

Try this interactivity to learn how to use advanced survey techniques.

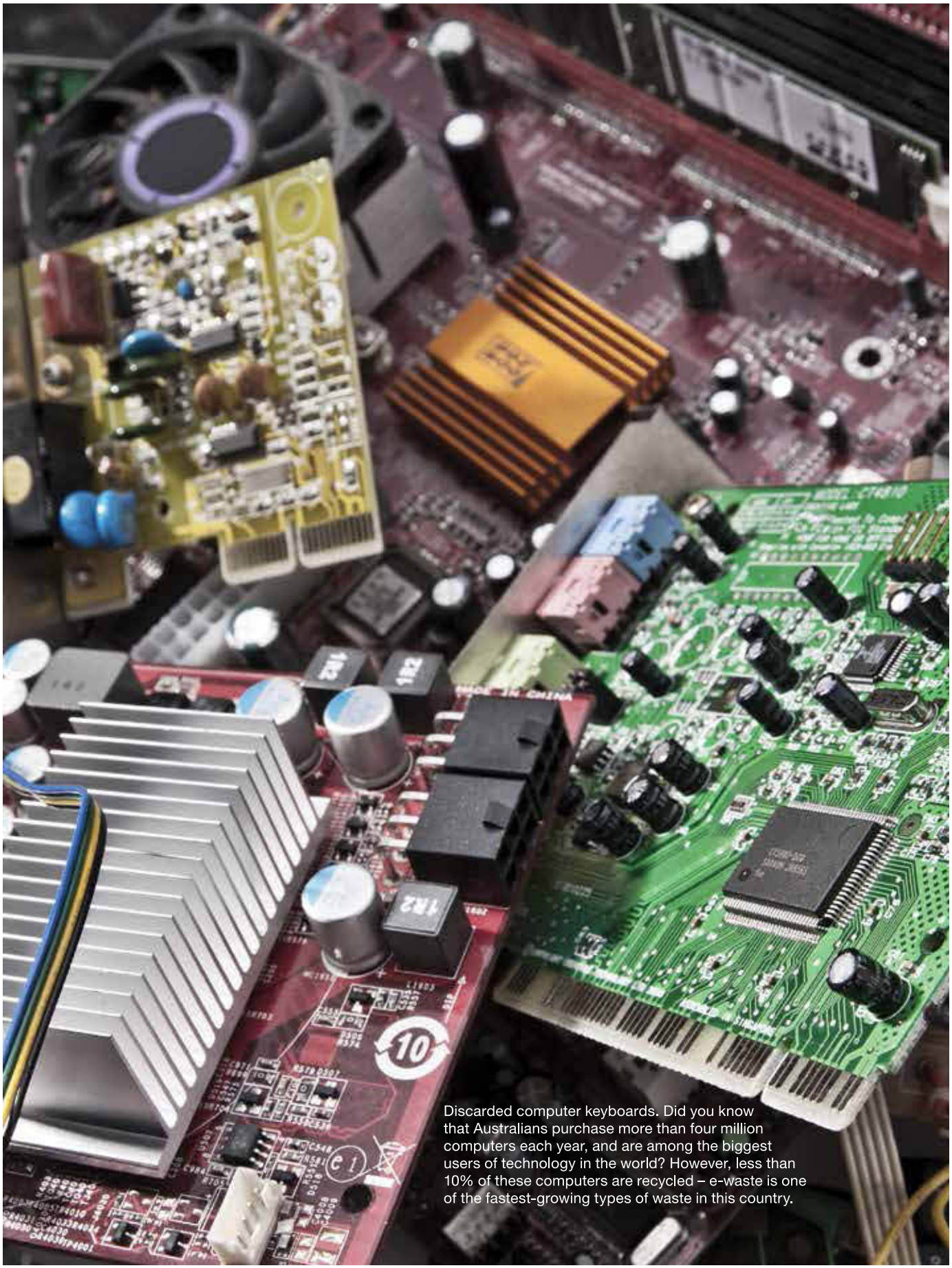


Searchlight ID: int-3360

eBookplus ONLINE ONLY

20.12 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



Discarded computer keyboards. Did you know that Australians purchase more than four million computers each year, and are among the biggest users of technology in the world? However, less than 10% of these computers are recycled – e-waste is one of the fastest-growing types of waste in this country.

20.3 SkillBuilder: Constructing a table of data for a GIS

20.3.1 Tell me

Why are there tables within GIS?

GIS, or geographical information systems, uses tables to organise and store information about points, lines and polygons (vector data). These tables have rows and columns, called fields. The GIS software links the rows in the table to the points, lines or polygons on a map. GIS software also stores data as pixels in an image, called raster data.

The tables can be drawn with a spreadsheet program and linked to a GIS if there is relevant information about location in the table. However, specialist software is required.

Why are tables useful in GIS?

Tables are very useful ways of storing large amounts of information, because they help to organise it. Creating tables makes it easy for GIS software to read data and to import or export the data to other programs, such as Excel.

A table allows us to access the original data. Maps, on the other hand, often use symbols and colours to represent information, and therefore they may not be as precise. Setting up the structure for a table helps us to understand how information may be stored digitally.

Model

A good table of data:

- places point, line and polygon features into separate tables
- has rows in the table that relate to the points, lines or polygons on the map
- has columns called fields, which store the data as numbers (integers) or text
- has column (field) names that are no more than ten characters long and contain no spaces
- identifies the date, source and collector of the data, and stores this in the GIS program — this is called *metadata* in a GIS.

20.3.2 Show me

How to construct a table of data

You will need:

- a piece of paper or a spreadsheet
- a data set — in this case, the results of a class survey about mobile phones.

Procedure:

Imagine that your class has conducted a survey to find out how many mobile phones there are in each home, asking the following questions:

- Where do you live?
- How many people are in your home?
- How many mobile phones are in your home?

You can use the responses to construct a table of data and use GIS to plot the results on a map.

STEP 1

Draw a table with rows and columns. For this data there should be 11 rows (for ten students plus the heading row) and four columns (see figure 1).

eBookplus

eLesson
Constructing a table of data for a GIS
Searchlight ID: eles-1743

FIGURE 1 Create a table with 11 rows and four columns.

STEP 2

Give each of the columns a heading to represent the data collected. Each heading must be short (no more than ten characters) and use underscores instead of spaces.

Create four columns: sample number, address, the number of people in the home and the number of mobile phones.

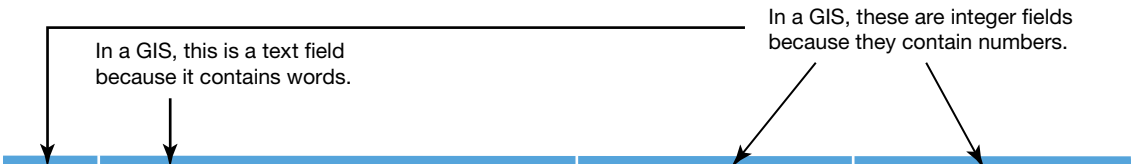
FIGURE 2 Give each column a short heading of no more than ten characters.

Sample	Address	No_home	No_mobiles

STEP 3

Identify which columns (fields) contain text and which contain numbers (integers). You have to set this first when using GIS software.

FIGURE 3 Work out which are text fields and which are number (integer) fields.



Sample	Address	No_home	No_mobiles

STEP 4

Enter the collected data into the table. A thematic map of the data can then be created using GIS software.

FIGURE 4 Enter the data into the table.

In a GIS, each row in the table is linked to a polygon on the map.

Sample	Address	No_home	No_mobiles
1	42 Jacob Street	2	4
2	27 Jacob Street	3	3
3	36 Adele Avenue	4	3
4	34 Flint Street	4	1
5	35 Flint Street	5	3
6	25 Flint Street	4	2
7	12 Jess Court	4	2
8	2 Jess Court	4	4
9	12 Flint Street	5	3
10	52 Jacob Street	6	2

There are two layers on the map. Each land parcel is coloured according to the number of people in the home, and the columns represent the number of mobile phones. The map is shown in figure 5.

20.3.3 Let me do it

Developing my skills

Create tables of data for the two maps shown in figures 6 and 7. Table 1 should be for the polygons (states) and table 2 for the points (ports). Table 1 should have two columns, or fields, and table 2 should have four columns. Identify the text and integer fields in each table.

eBookplus

Interactivity
Constructing a table of data for a GIS
SearchlightID: int-3361

Questions

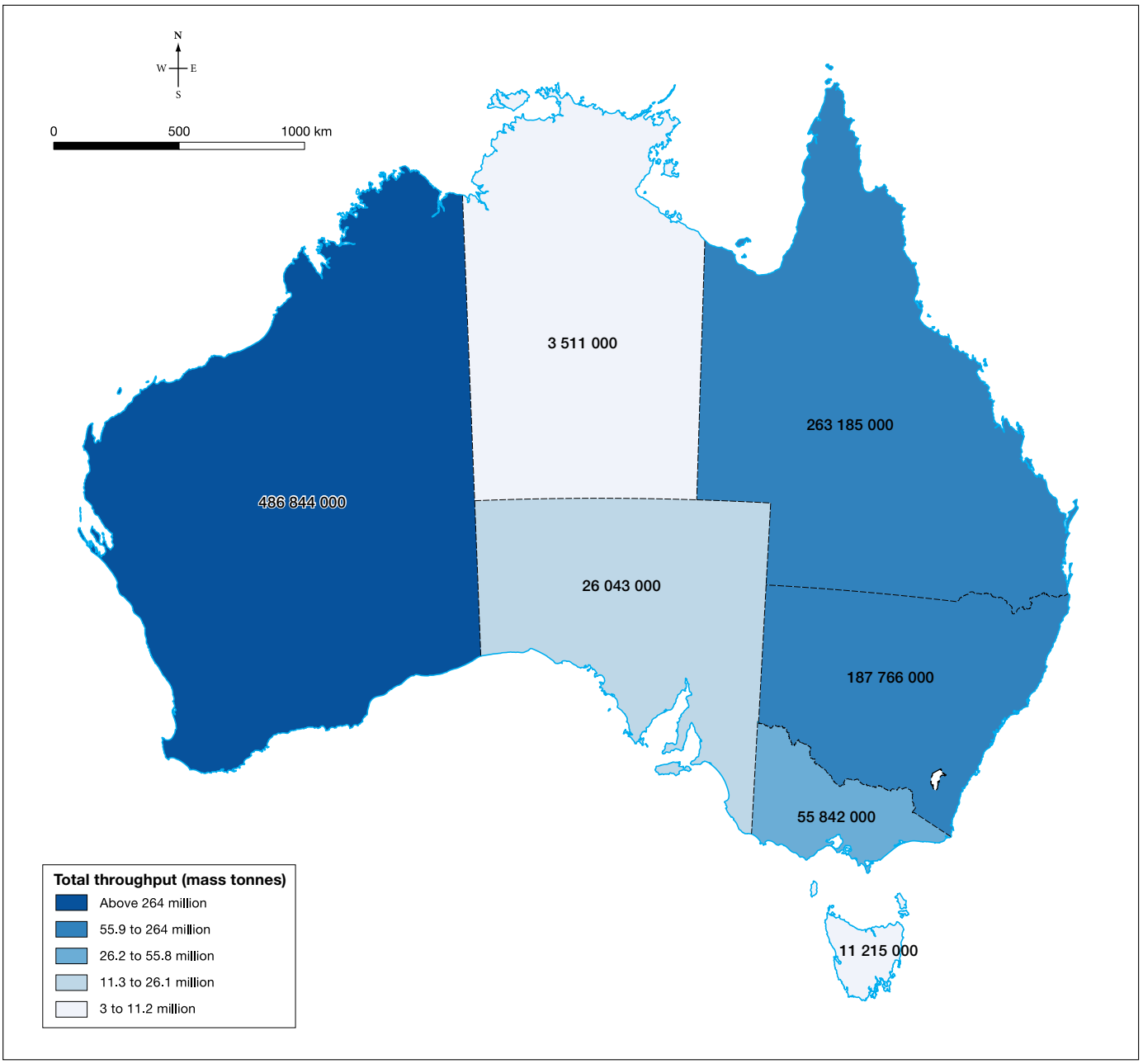
1. Which state handled the most cargo by tonnage in 2011–12, and which two states handled the least cargo?
2. Name the two main ports exporting:
   a. iron ore
   b. coal.
3. Compare the distribution of coal-exporting ports with that of iron ore–exporting ports. What does this tell us about the location of these resources in Australia?
4. Why are the values for wool exports much smaller than those for iron ore and coal?
5. Why do wool exports take place from ports in the southern part of Australia?

FIGURE 5 Map showing the number of mobile phones in each home



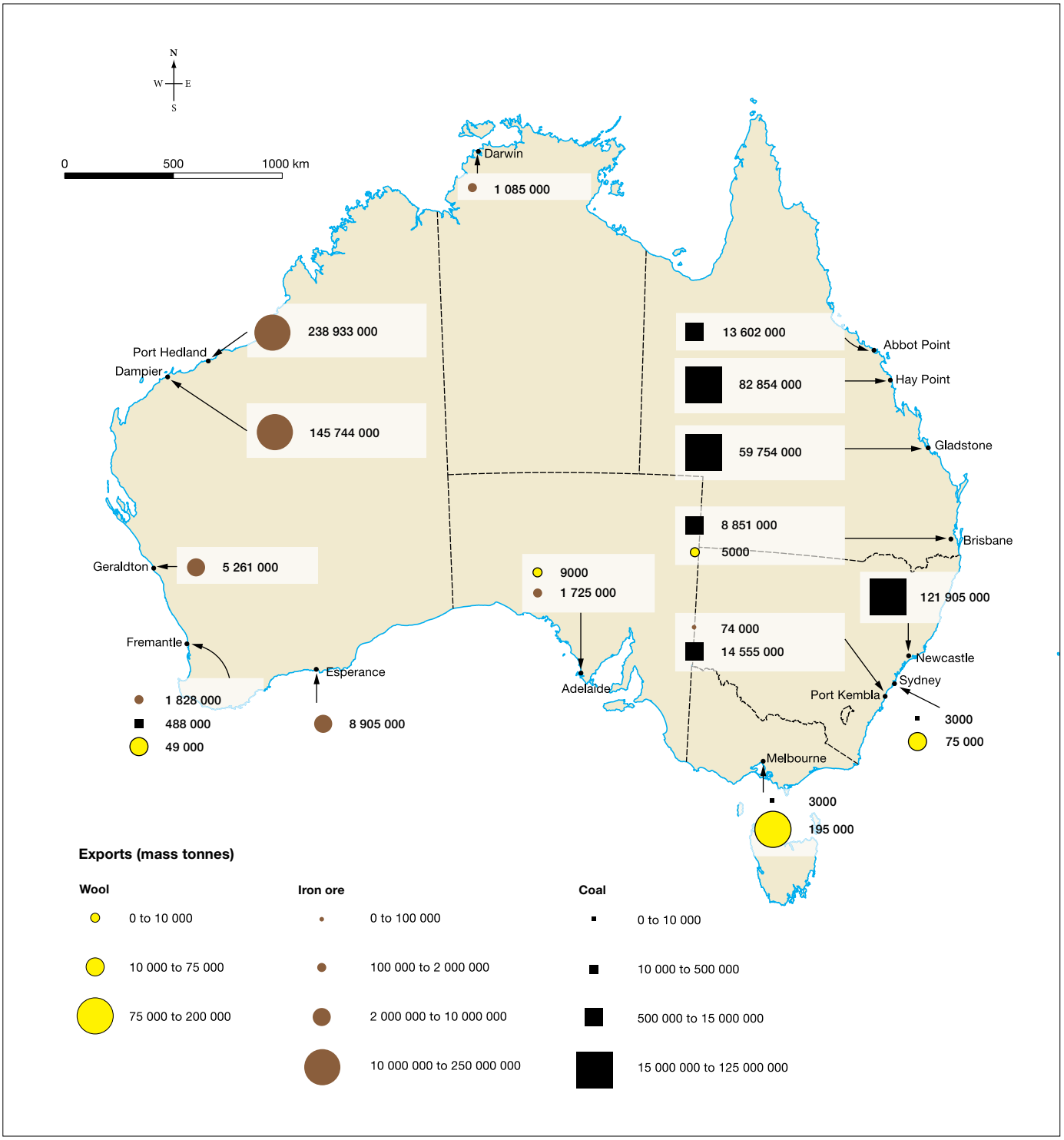
Source: Spatial Vision

FIGURE 6 Cargo handled by ports in Australian states and territories, in mass tonnes, 2011–12



Source: Spatial Vision

FIGURE 7 Ports exporting iron ore, coal and wool, in mass tonnes, 2011–12



Source: Spatial Vision

Checklist

I have:

- created separate tables for polygon and point data (and line data, where relevant)
- created rows in the table that relate to the points, lines or polygons on the map
- identified the text and numeric fields
- ensured that the field headings have been shortened if necessary and contain no spaces
- entered the data as correctly as possible
- added explanatory notes (metadata) about the source of the data and the values in each field
- included a title for the tables.

Skills questions

1. Why are two tables used to represent the information contained in the figures 6 and 7 maps?
2. There is always one more row to the table than the number of points, lines or polygons on the map because:
   a. the metadata is stored here
   b. the extra row is for a column of data
   c. the table of data needs a heading row
   d. rows are linked to places on the map, and it depends on the number of places.
3. Which statement about tables in a GIS is false?
   a. Text fields in a GIS table store numerical data such as quantities.
   b. Tables help to organise information for use by the GIS.
   c. A table may be drawn up in Excel and imported into the GIS.
   d. Text fields in a GIS store text information such as names and addresses.
4. Why is it necessary to shorten the field headings in a GIS?

20.8 How does e-cycling work?

20.8.1 Why recycle?

Recycling of e-waste is controversial, and is known to cause major health and environmental problems in developing countries. E-waste is one of the fastest growing types of waste. It should be noted, though, that e-waste is successfully being recycled in the United States, and that **de-manufactured** components are being shipped worldwide and reused.

Every year, as consumers, we purchase more and more electronic material that will eventually become e-waste. A United Nations study in 2015 found the United States is the biggest producer of electronic waste. Each year in the United States, 300 million computers and 1 billion cell phones are produced. It is estimated that only 11 per cent of e-waste is recycled. In comparison, Australian consumption of ICT is set to increase by 60 per cent in 2018. Today, only 35 per cent of e-waste is recycled.

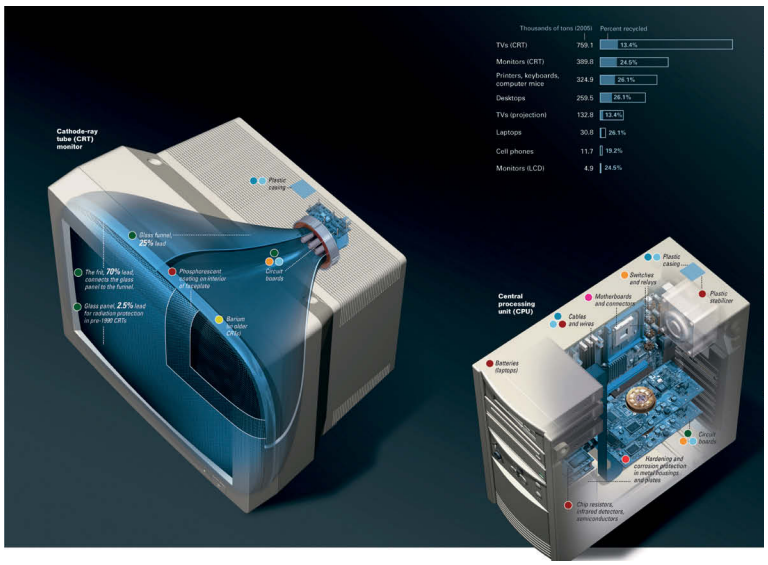
Electronic equipment contains poisons that can be hazardous to human health and to the environment if, for example, materials such as lead and cadmium are released from older model televisions and computer screens (see figure 1). Use the **High-tech trash** weblink in the Resources tab to take an interactive tour of the image shown in figure 1.

de-manufacture to disassemble devices into their original components for recycling

eBook*plus*

Weblink
High-tech trash

FIGURE 1 Toxic components in the central processing unit and cathode-ray tube monitor of a desktop computer



There are some challenges to the e-waste recycling process. It is not a universal process; for example, only 27 per cent of consumer e-waste was recycled in the United States in 2014. E-waste contains toxins, and if it is not recycled properly it has the potential to contaminate groundwater and soils.

The benefits of recycling

The benefits of recycling include:

- reduced need for landfill, dumps and incineration
- reduced build-up of hazardous waste
- more jobs
- conservation of natural resources
- greater sustainability.

20.8.2 What is URT?

Universal Recycling Technologies (URT) is an end-of-life processing company that deals with all types of electronics, including consumer electronics, security equipment, computers, communication equipment, network equipment, circuit boards and more. URT saves millions of tonnes of e-waste from entering landfill each year, thus protecting the environment.

e-Stewards certification an e-waste standard that bans exporting of hazardous electronic wastes to developing countries and outlaws the use of prisoners searching local dumps and landfills for e-waste

URT is a recycling company in the United States that has **e-Stewards certification**, the rules of which include the following:

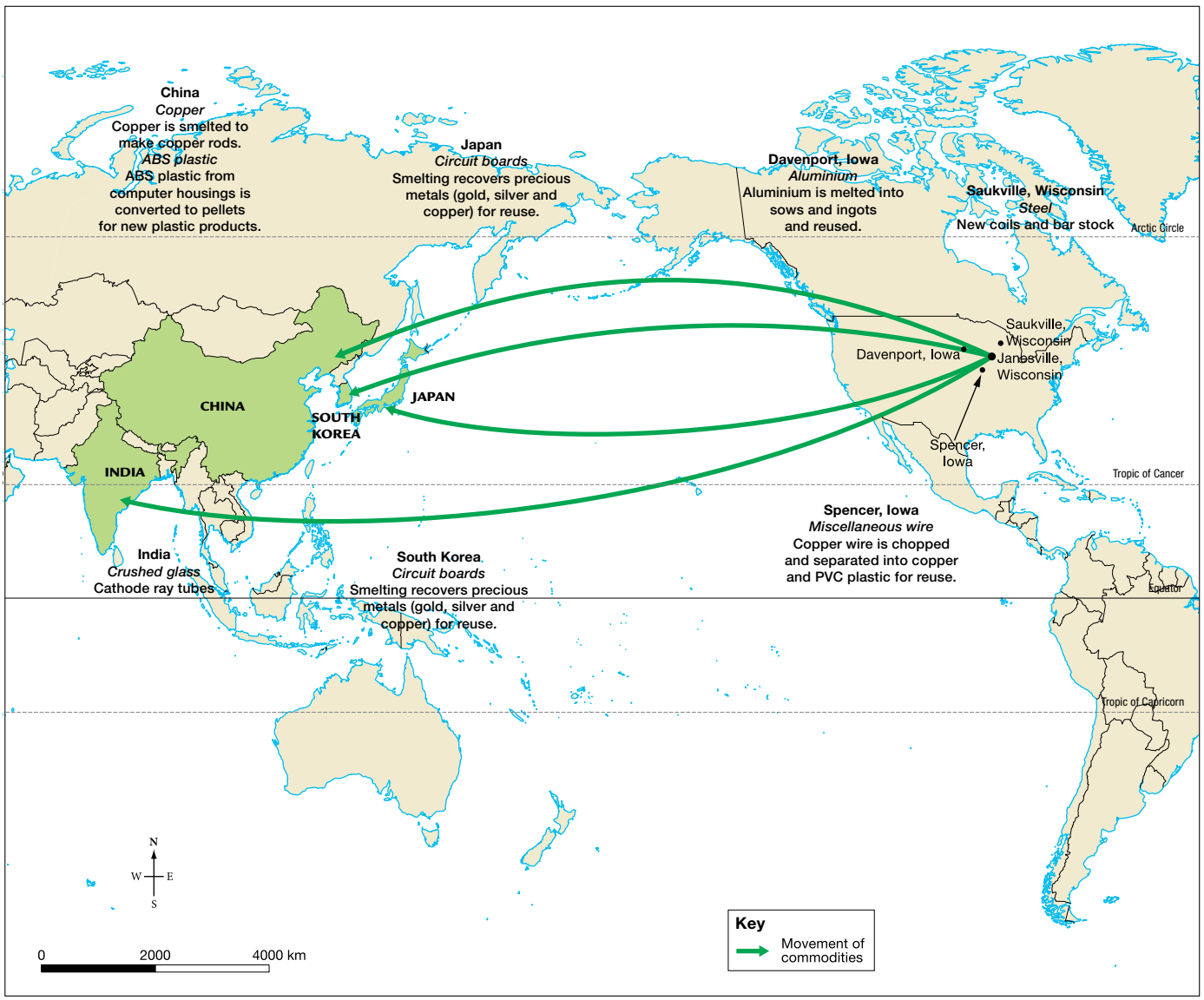
- recyclers must follow strict environmental and socially responsible practices
- all exports of hazardous waste are banned
- the use of prison labour to work on recycling is banned
- the dumping of waste in landfill is banned.

The company collects and purchases a wide variety of recyclable waste from municipal and retail locations across the country, and the waste is sorted and de-manufactured, or broken down to its original parts — a process similar to manufacturing but in reverse. Components such as glass, metals and plastic can then be retrieved. The harvested materials are then sold to other companies all over the world to be reused in other formats. For example, plastics are turned into carpet and glass goes into road asphalt, thus closing the recycling loop.

20.8.3 What are the recycling standards?

Ethical recycling ensures hazardous material is separated on site and all equipment is reduced to its original components. The e-Stewards program, of which URT is a member, is an e-waste standard that bans exporting of hazardous electronic wastes to developing counties, and also outlaws the use of prisoners searching local dumps and landfills. However, URT sends a lot of what it recovers overseas, and the commodities are often reused and repurposed, as shown in figure 2.

FIGURE 2 Location of commodity exports from Universal Recycling Technologies



Source: © Universal Recycling Technology. Map drawn by Spatial Vision.

ACTIVITIES

IDENTIFY

1 What does it mean for a recycling company to be a certified e-Stewards recycler?

APPLY

2 Make a list of all the electrical and electronic products owned by your family and, if possible, list the age of each. Classify them into white goods, communication and entertainment products. Using this information, create a bar graph. What is the oldest product in your household? What is the most common product for the class as a whole?

3 **a** What does your family do with its electrical and electronic waste?

b What does your school community do with its electronic waste?

PREDICT

4 Using the **e-Waste Recycling calculator** weblink in the Resources tab, calculate your e-Waste carbon footprint score. What steps can you take to reduce your e-waste carbon footprint score?

INVESTIGATE

5 The advantages of recycling are listed above. What would the disadvantages be?

eBook*plus*

Weblink
e-Waste Recycling calculator

20.11 SkillBuilder: Using advanced survey techniques — interviews

20.11.1 Tell me

What are interviews that survey people's opinions?

Surveys collect primary data, such as data that has been gathered in the field. Conducting a survey means asking questions, recording and collecting responses, and collating the number of responses. You can use basic questionnaires or more advanced sampling techniques, such as interviews. You can also use a variety of tally methods. A survey is taken from a few people in a population and is therefore a sample.

Interviews are particularly useful for gathering information on attitudes and values. The information that is gathered can be either quantitative (involving numbers) or qualitative (involving ideas) or both.

Why are interviews that survey people's opinions useful?

Surveys are useful because they provide data gathered for a specific topic that might not be available by other means. They allow a wide range of data to be gathered in an efficient and simple way.

An interview, which is an advanced survey technique, allows you to explore attitudes and values without being restricted by survey categories. It may be difficult to then quantify the responses, but an interview does offer great flexibility, with a wide range of question types and varied responses. You also have the chance to add questions during the interview to pursue an idea that is raised.

Interviews are useful for:

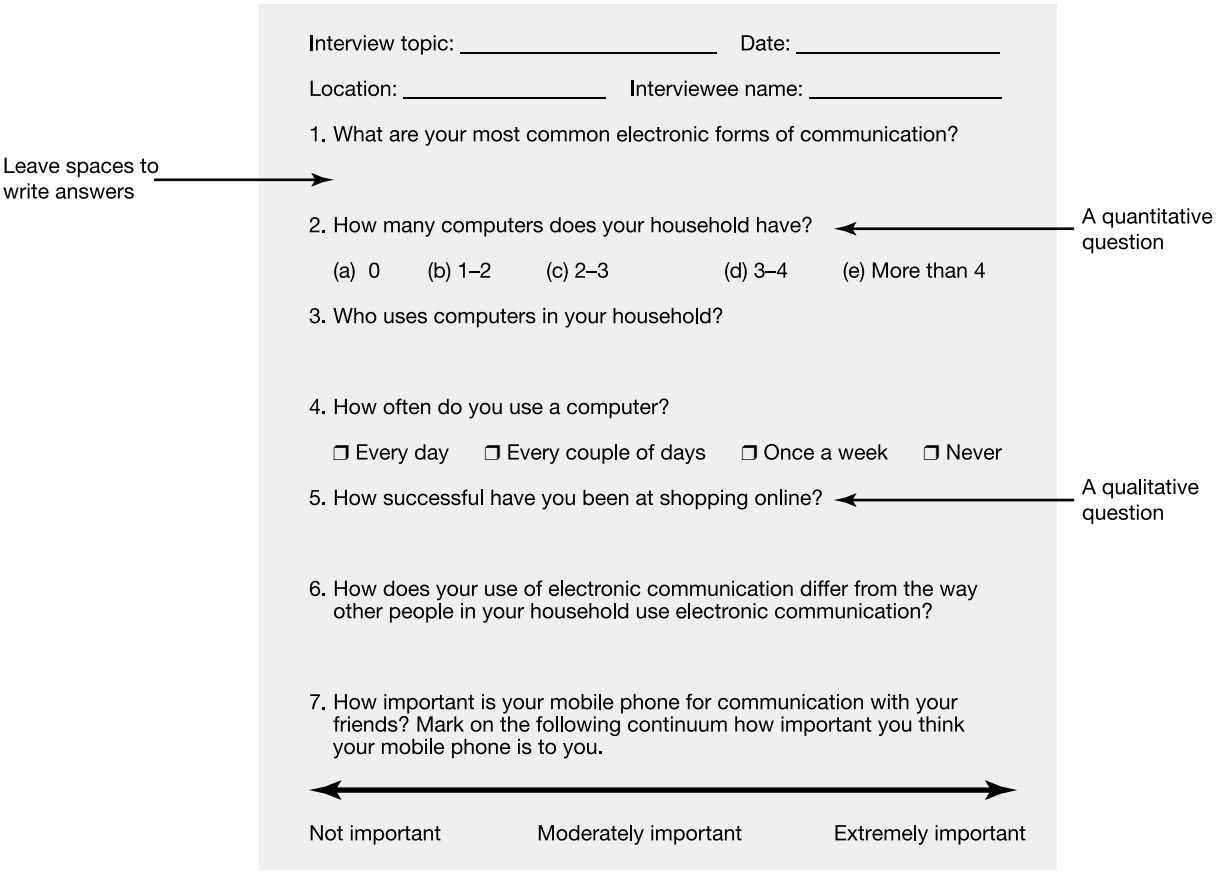
- obtaining data or information that may not be available from another source
- summarising people's activities, such as recreational activities
- providing a snapshot of people's opinions, values and attitudes
- testing people's perspectives on the world, such as how a person rates a feature
- improving your understanding of a topic by speaking with people, or by obtaining first-hand information before collating it.

Model

A good interviewer:

- thinks about the information that needs to be gathered
- works out which groups of people to interview — by age, gender, locality, business and so on
- decides on the best time to conduct the interview
- decides on the best place to conduct the interview — for example, in a park, in the middle of a shopping complex, in a cafe, or in an office
- writes a set of longer and more detailed predetermined questions
- writes open-ended questions that allow interviewees to express their opinions
- includes no more than about 15 questions to ensure people retain interest in the interview
- develops supplementary questions in response to anticipated answers
- sets a time limit of 15 to 20 minutes.

FIGURE 1 Sample interview questions



eBook*plus*

eLesson
Using advanced survey techniques – interviews
Searchlight ID: eles-1742

20.11.2 Show me

How to construct an interview

You will need:

- a computer on which to design your questions
- a list of people to interview
- a questionnaire
- pens for people to use to write their answers
- sound and/or video recording devices
- a risk assessment carried out by the school to ensure your safety in approaching people — ask your teacher and check with your family that it is okay to conduct an interview.

Procedure:

STEP 1

Determine the purpose of using the interview technique. What is your topic?

STEP 2

Begin by developing 10 to 15 questions that allow the interviewee to express their opinion. No question should be answerable with a simple yes or no. Figure 1 provides some sample questions.

STEP 3

Test your questions on a classmate or family member. Rework any questions to improve clarity of expression and to draw a more extended response from the interviewee.

STEP 4

You need to practise an interview on someone so that you are confident when talking to members of the public. When conducting an interview, use the following guidelines.

- Have some form of identification with your school on it so that people know you are genuinely collecting information.
- Introduce yourself and clearly state where you are from. Do not be offended if a person does not want to participate — this is their right.
- If you are going to record the interview, then seek permission from the person to do so.
- Explain to the person the purpose of the interview; that is, give some details about the topic to be discussed.
- Use a separate interview sheet for each person.
- Speak clearly so that you do not have to repeat yourself.
- Use a non-threatening tone of voice.
- Listen carefully to the answers given.
- Don't ask an interviewee to repeat their responses if they cover information for one question in the answer to another question. Write the information in the appropriate place on the sheet.
- Be prepared to slot in an additional question if the person has some great information to give you.
- Take notes, using your note-taking skills. Don't use full sentences — use key words and facts only — and don't make the person wait while you write.
- Try to keep your own opinion out of the answers; be neutral about the responses, even when you do not agree.
- Never interrupt an answer and always allow plenty of time for the interview — it should not go for longer than 20 minutes.
- Always thank the person for their time and support when you have finished.

STEP 5

Collating your information will take time, because you need to seek common themes through each interview. Quantitative data can be placed in tables. Qualitative data needs to be classified according to the percentage of people with the same or similar viewpoints.

eBookplus

Interactivity
Using advanced survey techniques – interviews
Searchlight ID: int-3360

20.11.3 Let me do it

Developing my skills

Create a set of interview questions that seek the opinion of your local community on e-waste. See subtopics 20.7 and 20.9 for some ideas. Gather your data and summarise your findings.

Questions

1. What did people understand by the term *e-waste*?
2. Does the community dispose of its e-waste effectively?
3. Are there enough e-waste recycling depots for the community?
4. Is there enough advertising about how to deal with e-waste?
5. Which local community groups ought to be responsible for e-waste management?

Checklist

I have:

- thought about the information that needs to be gathered
- worked out which groups of people to interview
- decided when is the best time to conduct the interview
- decided where is the best place to conduct the interview
- written a set of longer and more detailed predetermined questions
- written open-ended questions that allow the interviewees to express their opinions
- included no more than about 15 questions to ensure people retain interest in the interview
- developed supplementary questions in response to anticipated answers
- set a time limit of 15 to 20 minutes.

Skills questions

1. Interviews are used to show:
   a. more information than you have read
   b. your opinion on an issue
   c. the public's opinion on an issue
   d. special knowledge about an issue.
2. Interviews include information about:
   a. quantitative data only
   b. qualitative data only
   c. secondary data
   d. both qualitative and quantitative data.
3. Why is it important to be able to think on your feet while conducting an interview?
4. Why is it important to keep your own opinion out of the answers?

20.12 Review

20.12.1 Review

Uses of technology

1. Define *web 2.0*.
2. Describe the trend of internet and mobile phone use in Australia.
3. Explain the geographical pattern of internet use around the world.
4. Think about the reliability of the internet in middle-income and low-income areas. Create two PMI charts to compare.
5. Suggest reasons for different levels of home access to high-speed internet services across Australia.

Changes to technology

6. What is the *digital divide*?
7. Can the challenges posed by the digital divide be overcome?
8. How has mobile phone technology ***changed*** lives in Kenya?
9. Why is the NBN important for Australia's economy?
10. Use the **NBN** weblink in the Resources tab to research when then NBN is scheduled to become available in your local area.
11. Using the **Kindle coverage** weblink in the Resources tab, describe the access to the Kindle 3G network around the world. Explain why different areas of Australia have limited or no access.

e-waste

12. What is e-waste?
13. What are the challenges of e-waste in Europe?
14. List five different things you personally can do to reduce your e-waste.
15. With reference to figure 1, why do you think India, Pakistan and China are the main countries receiving e-waste?
16. Using figure 1, explain the geographical pattern of illegal dumping of e-waste. How are we in Australia ***interconnected*** to the information shown in this map?
17. With reference to figure 2, explain why e-waste is considered an ethical issue.
18. Refer to figure 2. Suggest what toxins this child may be exposed to and how they could affect his or her health.
19. What are the economic, social, political and ***environmental*** impacts of e-waste?

eBook*plus*

Weblinks

- Kindle coverage
- NBN

FIGURE 1 Who gets the trash? The movement of e-waste in the Asia–Pacific region



Source: Spatial Vision

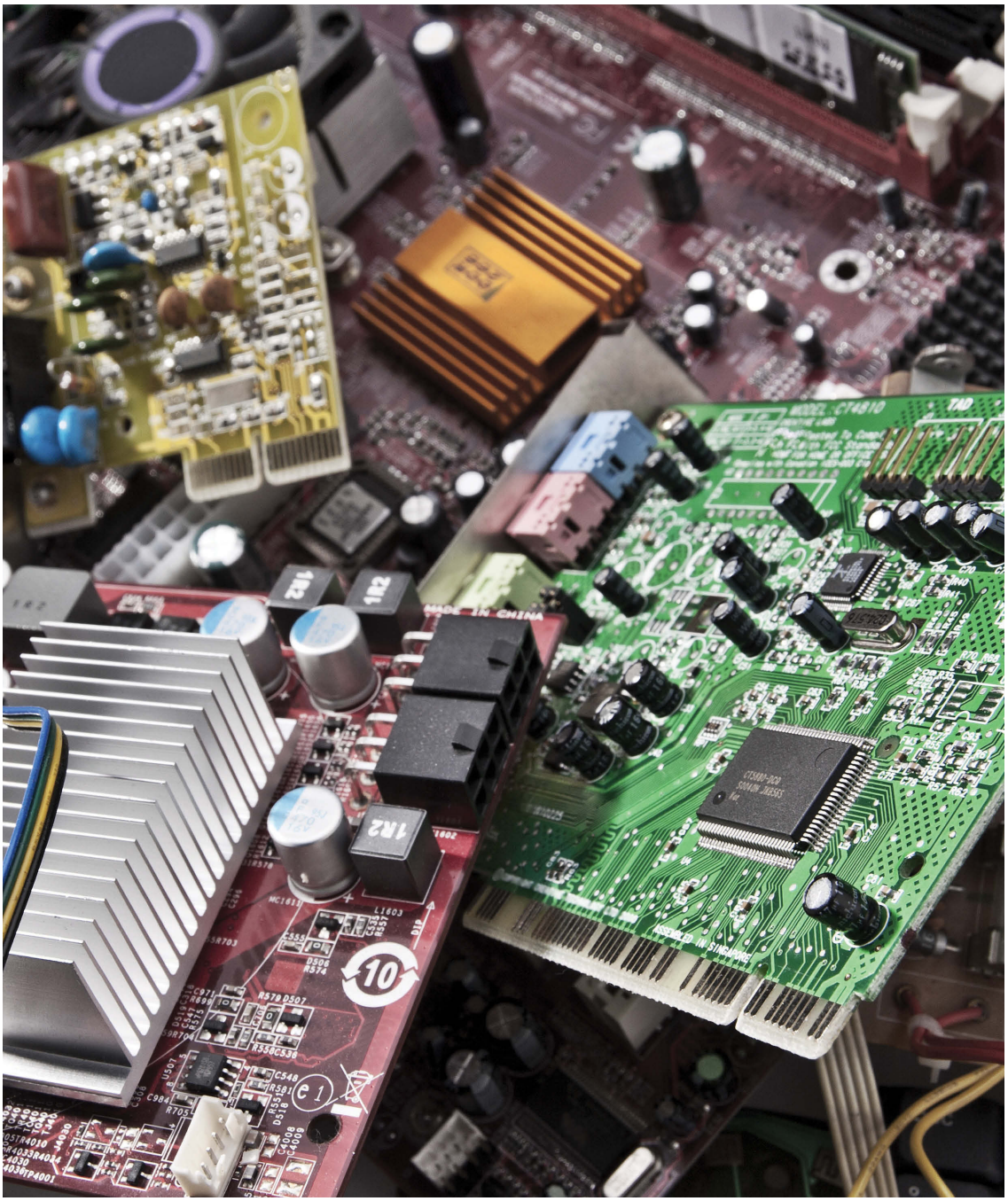
FIGURE 2 A child in China sits among a pile of wires and e-waste



20.12.2 Reflect

20. How can you change your behaviour to reduce your consumption and e-waste pattern?
21. How do you think information and communication technology will evolve in future?
22. What benefits do you think you will gain from the national broadband network?
23. Do you think that carbon emissions will curb improvements in information and communication technology?
24. Why are the connections you make through web 2.0 so important in your day-to-day life?

FIGURE 3 Discarded computer keyboards. Did you know that Australians purchase more than four million computers each year, and are among the biggest users of technology in the world? However, less than 10 per cent of these computers are recycled — e-waste is one of the fastest-growing types of waste in this country.



CHAPTER 21

Fieldwork inquiry: What are the effects of travel in the local community?

21.1 Overview

21.1.1 Scenario and task

Task: Produce a report about the impacts of travel movements around a local school or traffic hotspot, and devise a plan to better manage traffic and pedestrian movement.

People travel for many reasons at the local scale — for example, they may travel to work, to shops, to visit friends and to local sporting venues. Often there are times when traffic congestion occurs, creating danger areas for motorists and pedestrians. Examples of places where such congestion occurs are schools and shopping centres. Undertaking fieldwork allows you to observe and collect original data first-hand.

Your task

Your team has been commissioned by the local council to compile a report evaluating the impacts of travel movements around a local school or traffic hotspot. You will need to collect, process and analyse suitable data and then devise a plan to better manage future traffic and pedestrian movement in the area.



21.2 Inquiry process

21.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You can complete this project individually or invite members of your class to form a group. Save your settings and the project will be launched.

- **Planning:** Navigate to your Research Forum. Research topics have been loaded into the system to provide a framework for your research. You can also add your own new topics.
- As part of a class discussion, determine a suitable location for your fieldwork study. This might be your own or a local school, or a nearby shopping centre. Talk about some of the issues related to your fieldwork site and then devise a key inquiry question — for example: *What are the effects of . . . ?* or *How can we reduce the impact of . . . ?* This will be the focus of your fieldwork. You then need to establish the following:
  - **What** sort of data and information will you need to study the travel issue at your site?
  - **How** will you collect this information?
  - **Where** would be the best locations to obtain data?
  - **When** would be the best times of the day or day(s) of the week to obtain data?
  - **How** will you record the information you are collecting?

If you wish to collect people's views on the issue, or suggestions for improvements, you will need to plan and write suitable survey questions.

21.2.2 Collecting and recording data

As a class, plan the field trip by identifying and allocating tasks and possible sites to groups or pairs. It is often easier to share data collection. Once everything has been planned, you will need to perform your allocated tasks on the day.

In class, invite your school principal or a member of your local council to be a guest speaker discussing your fieldwork site. They may be able to assist with background information that you may not be able to gain elsewhere. They can also provide a different perception of the effects of travel at your

site. Plan a series of questions you would like to ask and be prepared to take notes that you can use in your report.

After the field trip, it may be necessary to collate everyone's data and summarise surveys so that everyone has access to the shared information.



21.2.3 Processing and analysing your information and data

Look at your completed graphs and maps. What trends, patterns and relationships can you see emerging? Within your fieldwork area, are there some places that have a bigger issue with cars and pedestrians than other areas? Is there an interconnection between traffic congestion and time of the day, or day of the week? What have your surveys revealed? What are the major effects of travel at your fieldwork site? How do people perceive the travel issues in this place? Go back to your key inquiry question. To what extent have you been able to answer it? Write your observations up as a fieldwork report using subheadings such as:

- Background and key inquiry question
- Conducting the fieldwork [planning and collecting data]
- Findings [results of data analysis].

Visit your Media Centre and download the report template to help you complete this project. Use the report template to create your report.

21.2.4 Communicating your findings

Now that you have identified a traffic problem and collected and analysed data, it is time to try to solve it. Your completed map and supporting data will form part of your management plan for the future. What have been the main issues that have emerged from your fieldwork research? How can you best manage these issues? Using your base map, create an overlay or annotated map to show possible options for reducing the traffic problem. You will need to support each proposal with data that you have gained from your fieldwork. Possible ideas could include:

- changing parking restrictions
- staggering times of drop-off and pick-up
- introduction of traffic wardens to guide traffic
- creation of a one-way system.

Your teacher may arrange for your completed report to be presented to your school or local council. Considering your audience, what is the best way to present your findings? You might like to produce a PowerPoint presentation or an annotated visual display.

21.3 Review

21.3.1 Reflecting on your work

Think back over how well organised and prepared you were for the fieldwork, the data you collected and how you processed the data for your report. Download and complete the reflection template from your Media Centre.

Print out your Research Report from ProjectsPLUS and hand it in with your fieldwork report and reflection notes.



Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

Suggested software

- ProjectsPLUS
- Microsoft Word or any other word processing tool
- PowerPoint or any other presentation tool

Media Centre

Your Media Centre contains:

- a sample traffic count data sheet
- a sample survey question sheet
- a report template
- an assessment rubric.



GLOSSARY

activity hub a centre for business activities that may or may not be the central business district

aerial view an image taken from above an object; also known as a bird's-eye view

aesthetic relating to something beautiful and pleasing to look at

alluvium the loose material brought down by a river and deposited on its bed, or on the floodplain or delta

altitude height above sea level

anonymity where a person's details, such as their name, are unknown

Anthropocene a period of time to describe the time when humans made significant changes to the Earth's environments

appropriate technology technology designed specifically for the place and the people who will use it. It is affordable and can be repaired locally.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater. Water can move along an aquifer.

artesian aquifer an aquifer confined between impermeable layers of rock. The water in it is under pressure and will flow upward through a well or bore.

Baby Boomers generally refers to those born during the post–World War II baby boom (1946–1964)

barter to trade goods in return for other goods or services rather than money

biodiversity the rich variety of all life forms on Earth, including plants and animals

bucket list a list of things a person wants to do before they die or 'kick the bucket'

built environment a place that has been constructed or created by people

carbon emissions carbon dioxide that is released into the atmosphere by natural processes or by burning gas, coal or oil, for example; the latter emissions are contributing to climate change

catchment area the area of land that contributes water to a river and its tributaries

census an official count or survey of a population, which often seeks and records other information about people. The Australian Bureau of Statistics conducts a national census every five years.

clearfelling a forestry practice in which most or all trees and forested areas are cut down

climate long-term weather patterns in an area

climate change a change in the world's climate. This can be very long term or short term, and is caused by human activity.

collate to organise the findings of fieldwork

community a group of people living in a particular region

commute to regularly make a journey such as from home to work

compost a mixture of various types of decaying organic matter such as dung and dead leaves

contour line a line joining places of equal height above sea level

convection current a current created when a fluid is heated, making it less dense, and causing it to rise through surrounding fluid and to sink if it is cooled. A steady source of heat can start a continuous current flow.

convectional rainfall heavy rainfall as a result of thunderstorms, caused by rapid evaporation of water by the sun's rays

converging plate a tectonic boundary where two plates are moving towards each other

cultural relating to the ideas, customs, and social behaviour of a society

cyclone intense low pressure system producing sustained wind speeds in excess of 65 km/h. It develops over tropical waters where surface water temperature is at least 27 °C.

degradation a decline in quality caused by time or improper use

delegate person sent or authorised to represent others, in particular an elected representative sent to a conference

delta a landform at the mouth of the river where a river splits into smaller streams and sediment is deposited to create an arch of land reaching out into the sea

deposition the laying down of material carried by rivers, wind, ice and ocean currents or waves

desertification the process by which an area becomes a desert

developed describes countries with a highly developed industrial sector, a high standard of living, and a large proportion of people living in urban areas

developing country nation with a low living standard, undeveloped industrial base, and low human development index relative to other countries

digital divide a type of inequality between groups in their access to and knowledge of information and communication technology

digital economy the network of economic and social activities that are supported by information and communication technology, such as the internet and mobile and sensor networks

discharge the volume of water that flows through a river in a given time

distribution the way things are spread across an area

divergent plate a tectonic boundary where two plates are moving away from each other and new continental crust is forming from magma that rises to the Earth's surface between the two

domesticate to tame a wild animal or plant so it can live with or be looked after by people

drainage basin the entire area of land that contributes water to a river and its tributaries; the whole area of land drained by a river and its tributaries

Dreaming in Aboriginal culture, the time when the Earth took on its present form, and cycles of life and nature began; also known as The Dreamtime. Dreaming Stories pass on important knowledge, laws and beliefs.

economic a system made up of producing, buying and selling goods and services

ecosystem an interconnected community of plants and animals in a particular environment

ecotourism tourism that interprets the natural and cultural environment for visitors, and manages the environment in a way that is ecologically sustainable

ecotourist a tourist who travels to threatened ecosystems in order to help preserve them

epicentre the point on the Earth's surface vertically above the focus

equatorial near the equator, the line of latitude around the Earth that creates the boundary between the northern and southern hemispheres

erosion the picking up, transport and depositing of weathered material; the wearing away and removal of soil and rock by natural elements, such as wind, waves, rivers or ice, and by human activity

ethnic minority a group that has different national or cultural traditions from the main population

evaporate to change liquid, such as water, into a vapour (gas) through heat

evaporation the process by which water is converted from a liquid to a gas and thereby moves from land and surface water into the atmosphere

evapotranspiration the process by which water is transferred to the atmosphere from surfaces such as the soil and plants

e-waste any old electrical equipment that includes computers, toasters, mobile phones and iPods that no longer work or are no longer required

expenditure the amount of money spent

extremism extreme political or religious views, or extreme actions taken on the basis of those views

fair trade a consumer-driven movement to promote fair prices and reasonable conditions for producers in developing regions. Fairtrade International is a group of 25 organisations trying to ensure a better deal for producers.

fault an area on the Earth's surface that has a fracture, along which the rocks have been displaced

field sketch a diagram with geographical features labelled or annotated

fissure a long, narrow crack or opening in the face of a rock

flood inundation by water, usually when a river overflows its banks and covers surrounding land

floodplain the area of land next to the river, usually reaching to the base of the mountains surrounding the catchment. It experiences flooding during peak rainfall periods.

fly in, fly out (FIFO) describes workers who fly to work in remote places, work 4-, 8- or 12-day shifts and then fly home

focus the point where the sudden movement of an earthquake begins

fossil fuels fuels that come from the breakdown of living materials, and which are formed in the ground over millions of years. Examples include coal, oil and natural gas.

gale force winds winds with speeds of over 62 kilometres per hour

Generation X those born after the baby boom, roughly between 1963 and 1980

Generation Y those born after Generation X, between 1981 and 1994

Generation Z those born after Generation Y, between 1995 and 2009

geomorphic describes a process that occurs in the lithosphere

geostationary satellites satellites that orbit with the Earth's rotation and appear to be stationary in the sky making locating features on the Earth's surface more accurate with GPS

geothermal energy energy derived from heat in the Earth's interior

glacier a large body of ice, formed by an accumulation of snow, which flows downhill under the pressure of its own weight

global citizen someone who is aware of the wider world, tries to understand the values of others, and tries to make the world a better place

globalisation the process that enables markets and companies to operate internationally, and products and ideas to be freely exchanged

gorge narrow valley with steep rocky walls

green building building that requires fewer resources when being built, and uses power and water efficiently

greenbelts plantations of trees for the purpose of conservation

gross domestic product (GDP) the value of all the goods and services produced within a country in a given period of time. It is often used as an indicator of a country's wealth.

groundwater recharge a process in which water moves down from the Earth's surface into the groundwater

habitat the total environment where an animal lives, including shelter, access to food and water, and all of the right conditions for breeding

halal describes food that is prepared under Islamic dietary guidelines

hard sport tourism tourism in which someone travels to either actively participate in or watch a competitive sport as the main reason for their travel

host an organism that supports another organism

hotspot an area on the Earth's surface where the crust is quite thin, and volcanic activity can sometimes occur, even though it is not at a plate margin

human features structures built by people

humanitarian principles the principles governing our response to natural disasters, such as tsunamis and earthquakes, or human-induced disasters, such as armed conflicts — the main aim being to save lives and alleviate suffering

humidity the amount of water vapour in the atmosphere

Hummer a type of car originally built for use by the US army; they are now often used in cities as stretched limousines

hydroelectric dam a dam that harnesses the energy of falling or flowing water to generate electricity

hydrologic cycle another term for the water cycle

ice age a geological period during which the Earth is colder, glaciers and ice sheets expand and sea levels fall. The last ice age was approximately 13 000 years ago.

improved drinking water water that is safe for human consumption

indigenous peoples the descendants of those who inhabited a country or region before people of different cultures or ethnic origins arrived

industry the production of goods and services

informal sector jobs that are not officially recognised by the government as official occupations and that are not counted in government statistics

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communications systems, water and power lines; the features that are built by humans to allow other

activities to occur, for example roads, electricity networks and water supply

inselberg an isolated hill, knob, ridge, outcrop or small mountain that rises abruptly from the surrounding landscape

intensify to become stronger

intermittent creek a creek that flows for only part of the year following rainfall

landfill a method of solid-waste disposal, in which refuse is buried between layers of soil

landslide a movement of rock, debris or earth down a steep slope (for example a mountain or cliff)

leaching a process that occurs where water runs through the soil, dissolving minerals and carrying them into the subsoil

levee also known as an embankment, it is a built-up part of the river bank

liquefaction a process whereby the shaking of an earthquake reduces or converts soil to liquid

literacy rate the proportion of the population aged over 15 who can read and write

lithosphere the Earth's crust, including landforms, rocks and soil

liveable city an informal name given to cities if they rank highly on a reputable annual survey of living conditions; a city that people want to live in, which is safe, well planned and prosperous, and has a healthy environment

location where a point on the Earth's surface is to be found

mantle the layer of the Earth between the crust and the core

Maasai ethnic group of semi-nomadic people in Kenya and Tanzania, whose way of life depends on their cattle

mass market the market for goods that are produced in large quantities

mass movements large areas of earth that move

mature-aged describes individuals aged over 55

meander a curve in a river caused by fast-flowing water eroding the bank of one side of the river and slow-flowing water depositing sediment on the other side of the river

mental map a drawing or map that contains our memory of the layout and distribution of features in a place

mercury poisoning a toxic condition caused by the ingestion or inhalation of mercury or a mercury compound. It has various symptoms, including vomiting, nausea, insomnia and fevers.

microclimate specific atmospheric conditions within a small area

mobility the ability to move or be moved freely and easily

monsoon the rainy season in the Indian subcontinent and South-East Asia

mound springs mound formation with water at its centre, which is formed by minerals and sediments brought up by water from artesian basins

national park a park or reserve set aside for conservation purposes

national security the protection of a nation's citizens, natural resources, economy, money, energy, environment, military, government and energy

natural disaster an extreme event that is the result of natural processes and causes serious material damage or loss of life

natural environment elements such as wind, soil, flowing water, plants and animals that influence the characteristics of an area

natural hazard an extreme event that is the result of natural processes and has the potential to cause serious material damage and loss of life

new moon the phase of the moon when it is closest to the sun and is not normally visible

nomadic describes a group or tribes that move from place to place depending on the food supply

nomadic lifestyle describes a lifestyle in which people do not live in one fixed spot but move according to the seasons from place to place in search of food, water and grazing land

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

nutrient an essential element that feeds living things to help them function and grow

OECD Organisation for Economic Co-operation and Development, which has 34 member countries and promotes policies that improve economic and social wellbeing

Pangaea the name given to all the landmass of the Earth before it split into Laurasia and Gondwana

patron a customer, especially a regular one

permafrost a layer beneath the surface of the soil where the ground is permanently frozen

pictorial map a map using illustrations to represent information

place specific part of the Earth's surface that has been identified and given meaning by people

plateau an extensive area of flat land that is higher than the land around it. Plateaus are sometimes referred to as tablelands.

population density the number of people living in a square kilometre

precipitation the form of water falling from the sky, such as rain, snow or hail

primary data information that you have collected where the researcher uses fieldwork techniques

primary industry industry involved in the gathering of natural resources, such as iron ore and timber, or activities such as farming and fishing

pull factors positive aspects of a place; reasons that attract people to come and live in a place

push factors reasons that encourage people to leave a place and go somewhere else

quaternary industry gathering information about an industry; for example, marketing furniture

rain shadow the drier side of a mountain range, cut off from rain-bearing winds

rainfall variability the change from year to year in the amount of rainfall in a given location

region any area of varying size that has one or more characteristics in common

regional centre the main town in a region

relative humidity the amount of moisture in the air

remote describes a place that is distant from major population centres

sea change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small coastal town

secondary data information that has been collected by another person. This could include websites, books or pamphlets.

secondary industry making raw materials into a more useful product; for example, making timber tables

sediment material carried by water

seismic waves waves of energy that travel through the Earth as a result

of an earthquake, explosion, or a volcanic eruption

selective logging a forestry practice in which only selected trees are cut down

settlement place where humans live together, e.g. houses, villages, towns and cities

shanty towns slum settlements housing the poor on the outskirts of major cities in developing nations. They lack basic services such as clean water, sanitation and electricity.

shifting agriculture process of moving gardens or crops every couple of years because the soils are too poor to support repeated sowing

sketch map a simple labelled drawing of an area using a bird's-eye view

soak place where groundwater moves up to the surface

social justice the aim to create a society that is based on equality, that values human rights, and that recognises the dignity of every human being

soft sport tourism tourism in which someone participates in recreational and leisure activities, such as skiing, fishing and hiking, as an incidental part of their travel

soluble able to be dissolved in water

sparse thinly scattered or unevenly distributed; often used when referring to population density

sparsely populated describes a region in which few people live

species a biological group of individuals having the same common characteristics and able to breed with each other

spot height a point on the map which shows the exact height above sea level at that place

stalactite a feature made of minerals, which forms from the ceiling of limestone caves, like an icicle. They are formed when water containing dissolved limestone drips from the roof of a cave, leaving a small amount of calcium carbonate behind.

stalagmite a feature made of minerals found on the floor of limestone caves. They are formed when water containing dissolved limestone deposits on the cave floor and builds up.

storm shelter underground shelter where people can take refuge from a tornado

storm surge a sudden increase in sea level as a result of storm activity and strong winds. Low-lying land may be flooded.

street view an image of a building taken from the road or footpath, at street level

subsistence producing only enough crops and raising only enough animals to feed yourself and your family or community

subsistence farming a form of agriculture that provides food for the needs of only the farmer's family, leaving little or none to sell

sustainable to use the environment now in such a way that it continues to support our lives and the lives of other living creatures into the future

sustainable development economic development that causes a minimum of environmental damage, thereby protecting the interest of future generations

tectonic plate one of the slow-moving plates that make up the Earth's crust. Volcanoes and earthquakes often occur at the edges of plates.

temperate describes the relatively mild climate experienced in the zones between the tropics and the polar circles

ten pound Pom the name given to British migrants who migrated to Australia after World War II. The fare to Australia was subsidised by the Australian government and cost only £10.

tertiary industry selling goods and services; for example, a furniture business

tertiary study the educational level following the completion of high school, e.g. university

Tornado Alley a region of the central United States, across which tornadoes are most likely to form. The core states are Texas, Oklahoma, Kansas, Nebraska, eastern South Dakota, and the Colorado Eastern Plains.

torrential rain heavy rain often associated with storms, which can result in flash flooding

trade barriers government-imposed restriction (in the form of tariffs, quotas and subsidies) on the free international exchange of goods or services

trading partner a participant, organisation or government body in a continuing trade relationship

transportation the movement of eroded materials to a new location by elements such as wind and water

tree change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small country town, in the bush, or on the land as a farmer

typhoon the name given to cyclones in the Asian region

UNICEF United Nations Children's Fund: a UN program that provides humanitarian and developmental assistance to children and mothers in developing countries

uranium radioactive metal used as a fuel in nuclear reactors

value adding processing a material or product and thereby increasing its market value

virtual water all the water used to produce goods and services. Food production uses more water than any other production.

volcanic loam nutrient-rich soil derived from volcanic ash deposits

vulnerable the state of being without protection and open to harm

water footprint the total volume of fresh water that is used to produce the goods and services consumed by an individual or country

water scarcity a situation that occurs when the demand for water is greater than the supply available; when annual water supplies drop below 1000 cubic metres per person. *Absolute water scarcity* describes the situation when annual water supplies drop below 500 cubic metres per person.

water stress a situation that occurs when annual water supplies drop below 1700 cubic metres of renewable fresh water per person

water vapour water in its gaseous form, formed as a result of evaporation

weathering the breaking down of rock through the action of wind and water and the effects of climate, mainly by water freezing and cooling as a result of temperature change

web 1.0 read-only version of the web. It enabled users only to search and read information.

web 2.0 version of the web that allows the sharing of online information and ideas that anyone has created. It is the second generation of the World

Wide Web that enables collaboration and exchanging of information online.

web 3.0 current version of the web. Focus is on connective intelligence; connects data, concepts, applications and ultimately people.

weir a barrier across a river, similar to a dam, which causes water to pool behind it. Water is still able to flow over the top of the weir.

wilderness a natural place that has been almost untouched or unchanged by the actions of people

winter solstice the shortest day of the year, when the sun reaches its lowest point in relation to the equator

World Heritage List a list of human and natural sites that have been approved by UNESCO as meeting the criteria of being a World Heritage site

INDEX

A

Aboriginal peoples
  aquaculture 268
  country and language 177
  Dreaming stories 50–1, 100–1, 264–5
  fossilised remains at Lake Mungo 88
  management of Uluru 61
  significance of water 267–8
  use of groundwater 265–6
absolute water scarcity 287
activity hubs 362
Adelaide, movement of sand northwards along beaches 18
adventure tourism 52–3
aerial view 164
aesthetic values
  landscapes and landforms 48
  mountain landscapes 101
  Uluru 58
  water 269–71
Africa
  formation of subtropical deserts 77
  political map 4
agriculture, and water scarcity 288
aid 214, 403–5
air travel 356
Airbnb 339
Airbus A380, production of 376
Alice Springs, climate 80
alluvium 306
alphanumeric grid references 189
Alps 98
altitude, water availability and 241
Amazon River 282–3
Anangu people 58–9, 61
Andes Mountains 98, 104
Anmatyerre people 267
Antarctic Desert 75
Anthropocene 62
appropriate technology 215
aquaculture
  in Asia 260
  Gunditjmara people 268
aquatic landscapes 25
aquifers 25, 37, 236
Arabian Desert 75
archipelagos 25
area references, topographic maps 30, 148
artesian aquifers 25, 37, 237
Asia
  aquaculture 260
  rice production 260
Asia–Pacific Economic Cooperation (APEC) 381
Atacama Desert, Chile 75, 78
atmosphere 130
  structure 245
atmospheric hazards 303
Australia
  age of continent 26
  aridity and water flows 30
  climatic zones 246
  landform regions 28
  natural hazards and disasters 302
  stages of European land settlement 166
  water resources 278–9
Australian Aid 214
Australian Alps 102
Australian cities sustainability index 209
Australian Conservation Foundation (ACF), sustainable cities index 209
Australian population, number born overseas 163–5
Australian Trade Commission (Austrade) 381
aviation, global warming and 348
Ayers Rock/Mt Olga National Park 61

B

Baby Boomers 370
backpackers 338
Badain Jaran Desert, China 82
Badu Island 216–17
Bakun Dam Project 143
Bangladesh
  flooding 311
  impact of climate change 323
  sweatshops 400
bar graphs 310
barter 385
Basel Convention 420
beaches, Australian cultural identity and 48
Beaufort scale 312
Ben Nevis, Scotland 107
Bidalinha (the Bubbler) 264
bike sharing 223–4
biodiversity 209
biological hazards 303
biological weathering 34
biosphere 130
Blue Mountains, formation 109
BOLTSS 44
Bonneville Salt Flats, Utah 84
Brazil, landslides in 2010 68
Brisbane, 2011 floods 307, 308
Brisbane City Council, property buy-back scheme 311
built landscapes 25
Bundjalung people 101
bushfires 302
Bushmen 90
Byron Bay, New South Wales 181

C

cafés 190
Canberra, satellite image 8
car industry
  in Asia 396
  in Australia 397–8
  leading manufacturers 396
  technological advances 356–7
  in United States 396–7
carbon emissions, reducing 424
Carmichael, Aunty Beryl 50
catchment areas
  changes from upper to lower reaches 150–1
  lower catchment 239
  mid reaches 239
  modification of vegetation 306
  upper catchment 239
  water quality 328–9
caves *see* karst landscapes
census 220
change, as geographical concept 11–12
Chatham County, Georgia 321
chemical weathering 34
Chihuahuan Desert 82
China, foreign-owned enterprises 399
Chinese New Year 343–4
choropleth maps 288, 291
cinder cone volcanoes 121
city sustainability index 209, 212
clearfelling 139
climate
  distinguished from weather 246–7
  effect on water availability 279–81
  temperate climate 211
climate change
  extreme weather events 322–4
  observed evidence of 243
  water availability and 242
  water scarcity and 289
climate change conference, Paris 2015 371, 372
climate graphs/climographs 80, 210
climatic zones, Australia 246
climometers 103
clothing industry
  in Australia 399
  globalisation and 398–400
clouds, types 243
coastal deserts 78
coastal fieldwork 40–2
coastal landscapes, features 40
cold deserts 74
column graphs 310
commercial logging 139
community, sense of 171
community identity, influences on 198–200
community-led total sanitation (CLTS) 262
commuting 223
complex overlay maps 133
composite volcanoes 121

compost 131
computers
  composition 419
  recycling 423, 424
connectedness, influencing factors 199–200
continental drift 104–5
continental islands 25
continental plates 104–5
contour lines, on topographic maps 45, 118
convection currents 104
convectional rainfall 128
convergent plates 104–5
Copenhagen, public transport 362–3
crescent dunes 81
cross-sections 116
cultural identity, loss of 372
cultural tourism 343–4
cultural value
  landscapes and landforms 50–1
  mountain landscapes 101
  Uluru 58–9
  water 263–5
culture, community identity and 198
cumulative line and bar graphs 387
Cyclone Pam 324
cyclones 302
  classification 316
  formation 315–16
  impact 316

D

Daintree Rainforest 135, 148
Daintree River National Park, topographic map of south-eastern section 149
Dalhousie Springs 265
dams
  Bakun Dam Project 143
  flood management 310
  hydroelectric dams 140
  Three Gorges Dam 283
data
  analysing 151, 227, 329, 431
  collection and recording 151, 227, 328–9, 430–1
Dawson, Canada
  climate 202–3
  contemporary life 202–3
  location 201–2
  settlement 202
deforestation
  commercial logging and 139
  disease and 145
  displacement of Indigenous people 143
  farming and 139–40
  impacts 141–5
  landslides caused by 144
  loss of species diversity 141–3
  mining and 140–1
  and orangutans in Indonesia 142–3
deltas 239
Department of Foreign Affairs and Trade (DFAT) 381, 404
deposition 26, 27, 34, 35
depositional landforms 81
desalination plants 90, 284
desert landforms
  depositional landforms 81
  erosional landforms 81
  playas and pans 83–4
  sand dunes 75, 81–3
  types 83
desertification 94
deserts 24
  in Australia 75, 85–6
  climate and formation 76–80
  coastal deserts 78
  cold deserts 74
  definition 74
  global distribution 74, 75
  hot deserts 74
  inland deserts 79
  Lake Mungo and Willandra Lakes 87–9
  management 94
  mining 91–2
  polar deserts 79
  rain-shadow deserts 77–8
  rainfall 80
  resources 90–1
  subtropical deserts 76–7
  temperature 79, 80
  traditional communities 90
developing countries 400
diagrams, interpreting 235, 236
digital divide 410–11
digital economy 368, 415
disease
  and access to clean water 261–3
  deforestation and 145
  water-borne diseases 261
distance, effect on lifestyle 191–3
divergence graphs 347
divergent plates 105
dome dunes 82
dome mountains 107
dome volcanoes 121
domesticated animals 62
doughnut charts 340
drainage basins
  Amazon River basin 282
  in Australia 28, 29, 278
  diagram 239
Dreaming stories 50–1, 100–1, 264–5

E

e-waste
  definition 418
  environmental impacts 419–20
  global movement of 11, 421
  health impacts 419, 420
  international management 420–1
  local management 421–2
  recycling countries 11, 421
  recycling options 423–5
Early Cretaceous period 134
Earth, age of 26
earthquakes
  impacts 114–16
  intensity 111
  and landslides 65, 115, 116
  liquefaction 116
  magnitude 111
  measuring 110, 111
  in Nepal 2015 111
  occurrence of 110–11
  ten biggest 114, 115
  and tsunamis 112
Eastwood Brickworks 160–1
Eastwood, Sydney 159–60
economic value
  landforms and landscapes 52–3
  Uluru 60
  water 259–60
economic water scarcity 287, 288
ecotourism 147, 350–1
Ecotourism Australia (EA) 351
education
  access to 189
  Flying Scientist 192
  School of the Air 191, 192
  tertiary study in regional centres 193
employment opportunities 187–8
energy production, water scarcity and 289
Enhanced Fujita scale 312–13
environment
  community identity and 198
  as geographical concept 13
  impact of global connectivity 371, 372
epicentre 110
equatorial regions 128
erosion 26, 27, 33, 34, 35, 63
erosional landforms 81
ethnic minorities 100
European Union (EU) 420
evaporation 244, 280
evapotranspiration 142
Evocities 169, 170, 191
exosphere 245
exports 6, 383, 388–9
extensive land use 187
extreme weather events 244
  predicting 322–4
  preparing for 320–2
  responses to 324–5
extremism 403

F

facilities
  variations in access 191
  wellbeing and 189–90
fair trade 385, 401–2
Fairtrade International 401
farming
  deforestation 139
  landscape degradation 62–3
fault-block mountains 107, 108
favelas 10, 68
festivals 198
field sketches 41, 42, 43

fieldwork 5–6
fieldwork inquiries
analysing data and information 151, 227, 329, 431
communicating findings 151, 227, 329, 431
data collection and recording 151, 227, 328–9, 430–1
effects of travel in local community 430–1
local catchment changes from the upper to the lower reaches 150–1
process 150–1, 226, 328, 430
reflecting on your work 151, 227, 329, 432
water quality of local catchment 328–9
water quality of local waterways 257–8
your local place 226–7
Financial Deepening Challenge Fund (FDCF) 413
fishing
traditional methods 13
unsustainable nature of 13
fissures 59
flood management 310–11
flooding
Bangladesh 311
Brisbane 307, 308
causes 305–6
impacts 307–9
La Niña events and 307, 308
and landslides 65
Narrabeen Lagoon 326
preparing for 325
storm surges 316
water cycle and factors affecting 8
floodplains 27, 239, 306
flow diagrams 346
flow maps 379, 380
Fly in and Fly out (FIFO) 157
Flying Doctor 193
Flying Scientist 192
fold mountains 106
food trade 385–7
football, travelling for 191, 192
foreign aid 214, 403–5
fossil fuels 232
fossil water 238
Franz Josef Glacier 298
Free Trade Agreements 382, 398
freight, interstate and regional 378–9
freshwater landscapes 25
Fujita scale 312

G

gale force winds 316
GDP (gross domestic product) 334, 408–9
Generation X 370
Generation Y 370
Generation Z 369–70
geographic information systems (GIS) 7, 49, 410
geographical concepts
application 18
change 11–12
environment 13
interconnection 11
place 10
scale 14–15
space 9
SPICESS mneumonic 9
sustainability 13
geographical inquiry, nature of 2–3
geographical questions 3
geographical skills 3, 15–16
geographical tools 4–8
geography, careers 15–17
geological hazards 303
geology, water availability and 242
geomorphic hazards 64
geomorphological processes 32
geostationary satellites 49
geothermal energy 123
Gibson Desert 86
GIS *see* geographic information systems (GIS)
glaciers 25, 27, 298
Glasshouse Mountains 26
global citizens 15, 214
global connectivity
negative impacts 372
positive impacts 371
Global Connectivity Index (GCI) 371
Global Liveability Ranking 208
Global Positioning System (GPS) 7, 49
global warming, aviation industry and 348
globalisation
and clothing industry 398–400
definition 398
Gobi Desert 75, 79
Gondwanaland 134
Google Earth 7, 49, 132
gradient, calculating 117
Grand Canyon National Park, United States 53
Grand Canyon, United States 33
graphs 6
grasslands 25
Great Artesian Basin 27, 28, 90, 265, 296
Great Barrier Reef 270
Great Basin Desert 75
Great Dividing Range 78
Great Northern Railway 266
Great Rift Valley 107
Great Sandy Desert 85
Great Victoria Desert 85
green buildings 209
greenbelts 94
grid references
alphanumeric grid references 189
topographic maps 30, 148
Griffith, New South Wales
sense of place 172
topographic map 173
gross domestic product (GDP)
and global connectivity 371
ICT expenditure 408–9
tourist industry contribution to 334
groundwater 236–8
groundwater recharge 237
groundwater sources, mound springs 264–5, 265–6
groundwater stress, global areas 289
Gunditjmara people 268
Gunnedah Shire, New South Wales
location and major industries 70
topographic map 71
Gunnedar people 70

H

Haast, New Zealand
features of region 248
topographical map 249
Haiti, landslide risk 144
halal 386
Happy Planet Index 208
hard sport tourism 342
hardpans 83–4
hardwood alternatives 146
healthcare
access to 190
Flying Doctor 193
Higgins, Phil 192
Higgins, Suzanne 192
Himalayas 98, 108
historic settlements, transport networks and 186–8
Honda Motor Company 396
hot deserts 74
hotspots 27, 104, 105
Huli people, Papua New Guinea 137
Human Development Index (HDI) 404
human features (landscape) 40
humanitarian principles 403
humidity 76, 280
Hurricane Jean 144
hydroelectric dams 140
hydrologic cycle 234–5
hydrological hazards 303
hydrosphere 130

I

ice ages 62, 134
icecaps 27
ICT (information and communication technology)
access to 411, 412
anonymity and internet trolls 370
connections to people 369–70
connections to services and information 367–8
and death of distance 369
expenditure 408–9
negative impacts 372
positive impacts 371
social media 369
uses 366
youth culture and 364
imports 383
Indian Ocean tsunami 2004 113
Indigenous peoples
definition 100
displacement due to deforestation 143–4
in mountainous regions 100

Indigenous peoples *(continued)*
rainforest communities 136–8, 143–4
see also Aboriginal people; Torres Strait Islander people
Indo-Australian plate 108
infiltration 235
informal sector 219
information and communication technology *see* ICT (information and communication technology)
infrastructure 202, 310
inland deserts 79
inland settlement in Australia 166–7
inselbergs 58
intensive land use 187
interconnection, as geographical concept 11
intermittent creeks 86
International Convention on Wetlands 56
internet access
in Australia 365
digital divide 410–11
importance of improving 412
National Broadband Network 415–18
regional differences 368, 408, 411
in rural and remote Australia 416, 417
internet trolls 370
internet use
data consumption 417–18
youth culture and 364
interviews, using as survey technique 428
Iranian Desert 75
irrigation
in Australia 255
circular irrigation in Saudi Arabia 91
islands 25

J

Jabal La'lam 102
Japanese tsunami, 2011 112
job opportunities 187–8
Jordan River Basin 294, 295
Jurassic period 134

K

Kalahari Desert 75, 90
Kamilaroi nation 70
Kangaroo Island, South Australia 181
karst landscapes
formation 37, 38
locations 37, 38
nature of 25, 37
Kenya, M-Pesa 413–15
Kewson Hill 265
Khormaksar, Yemen, climate 80
Kombai people, Papua 138
Korowai people, Papua 138
Kuku Yalani people 135

L

La Niña 307, 308
Lake Condah 268
Lake Eyre 28, 29, 38, 265, 266, 279
Lake Mungo 87–9
Lake Torrens 30, 266, 279
lakes, in Australia 278
land features, recognising 32
land use, in Australia 186–7
landfill 423
landforms
aesthetic values 48
cultural and spiritual value 50–1
economic values 52–3
landform regions in Australia 28–9
processes shaping Australian landforms 26–7
landscape degradation, caused by human activities 62–4
landscapes
aesthetic values 48
cultural and spiritual value 50–1
economic values 52–3
erosion 33
impact of water 34–6
processes of transformation 32–4
tectonic forces and 33, 34
types 24–5
landslides
in Australia 66–7
causes 65–6
definition 64
deforestation and 144
earthquakes and 65, 115, 116
impacts 66
responding to 68
types 65
Late Cretaceous period 134
Late Oligocene period 134
lateral plate slippage 105
latitude 93, 241
leaching 63
levees 239, 310, 311
Libyan Desert 79
lifestyle places 174–6
line graphs 213, 256, 387, 388
linear dunes 82
linear scale 45, 337
liquefaction 116
literacy rate 219
lithosphere 64, 106
Little Sandy Desert 85
liveability
Badu and Moa 216–17
definition 206–7
factors influencing 159
favourite places in Australia 180–1
improving 213–15
least liveable cities 209
measuring 208
Port Moresby 217–19
studies into 220–1
sustainability and 209, 212
top ten cities 211
transport strategies 222–4
livestock trade 386–7
local relief, calculating 117
longitude 93
lowland tropical forest 129

M

M-Pesa 413–15
mail order catalogues 193
malaria 145, 261
Manizales, Colombia, landslide 2011 144
mantle 33
map reading 43
maps 4–5
Marble Bar, Western Australia 79
Mariana Trench 105
marine landscapes 25
Masai people 336, 415
mass movements (earth) 64
mature-aged tourists 338
meanders 239
medical tourism 336–7
Mekong River 295
Melbourne 181, 362–3
Melbourne Docklands 174–5
mental maps 178
Mercer Quality of Living Survey 208
mercury poisoning 419
mesosphere 245
microclimates 131
microfinance 214
Millennium Development Goals 214, 261, 262–3, 404
mining
and deforestation 140–1
in deserts 91–2
open cut mining 64
in remote locations 167, 168
Miocene period 134
Mitchell River 283
Moa Island 216–17
mobile phone coverage 193, 413, 414
mobile phone ownership
in Australia 408, 409
changes in 367
in Kenya 413–15
throughout the world 367–8, 408, 411
mobile phones
as pocket computers 366
recycling 423–4
MobileMuster 423
Mohave Desert 78
Monkey Mia, Shark Bay 180
monsoon 311
montane rainforests 128–9
Most Liveable Cities Index 208
mound springs 264–5, 265–6
Mount Etna, Italy
liveability 196
topographic map 197
Mount Everest 24, 102, 105
Mount Gunung Agung 101
Mount Kallas 101

Mount Taranaki, New Zealand
formation 118
topographic map 119
mountains 24
climate and weather 99
formation of 104–5
global distribution 98–9
peoples and cultures 100–1
sacred and special places 101–2
survival skills 102
types 105–9
Mt Fuji 102
multiple line graphs 388
'Mungo Lady' 88
'Mungo Man' 88
Murray–Darling Basin 28, 29, 87, 295

N

Namib Desert, Africa 75, 78, 82
Nanda Devi 102
Narrabeen Lakes, NSW
flooding of lagoon 326
topographic map 327
National Broadband Network (NBN) 415–18
National Critical Care and Trauma Response Centre 324
national parks and reserves 56, 336
National Parks and Wildlife Service (NPWS) 56
national security 403
National Television and Computer Recycling Scheme 424
natural disasters, impacts 303
natural hazards 64
in Australia 302
definition 302
responding to 304
types 303
neighbourhoods 176–8
Nepal, earthquake 2015 111
new moon 343
Ngiyaampaa Dreaming 50–1
Niagara Falls 283
Nigeria, community-led total sanitation (CLTS) 262
Nile River Basin 295
nomadic peoples 90, 138
non-government organisations (NGOs)
aid programs 214
definition 214, 413
emergency aid 324
and fair trade 402
setting up of M-Pesa in Kenya 413
water projects 292
non-perennial rivers 278
non-renewable resources 232
Noosa, Queensland
topographic map 275
values of water 274
North America, deserts 75
Nouakchott, Mauritania
desertification 94
topographic map 95
Nullarbor Plain, karst cave system 37
nutrients 63

O

ocean currents 241
oceanic islands 25
oceanic trenches 105
OECD (Organisation for Economic Cooperation and Development) countries 403, 416, 420
Official Development Assistance (ODA) 403
offshore companies, top 30 locations 400
oil trade, flow line map 5
Ok Tedi mine, Papua New Guinea 140–1
Old Bubbler (spring) 264
Olympic Games, costs and benefits 341
online shopping 193, 368
Oodnadatta Track, groundwater springs 264–5, 265–6
open cut mining 64
open spaces, connectedness and 200
orangutans 142–3
overlay maps 222
overseas-born Australians 163–5

P

Pacific Islanders, sustainable fishing 12
Pacific Ring of Fire 105
Palau, impact of Typhoon Haiyan 319
palyas 83–4
Pangea 108
parabolic dunes 83
Paraisópolis favela (slum), São Paulo 10
Parks Australia 61
Patagonian Desert 75
Pedirka Desert 86
Penan people, Borneo 137–8
perennial rivers 278
permafrost 25, 202
Perth, public transport 362
Philippines, impact of Typhoon Haiyan 318–19
photographs, annotating 258, 259
physical water scarcity 287, 288
physical weathering 34
pie charts/graphs 285, 287
pituri 266
place
as geographical concept 10
sense of place 156–7
places, changes over time 159–62
plateau mountains 107
plateaus 24, 58
Points of Interest (POI) 49
polar deserts 79
polar landscapes 25
political maps 158
pollution, water pollution 257
population, and water scarcity 288
population density 211
population profiles 165
population pyramids 194
Port Botany 358–9
topographic map 359
trade facilities and links 358
Port Douglas, Queensland 12
Port Moresby, Papua New Guinea 217–19
Port of Newcastle 384
Port of Singapore 391, 394
ports
largest bulk shipping port in Australia 384
largest in the world 357
operations 390
positional language 54
precipitation 244
précis maps 135
primary industry 378
Product Stewardship Act 2011 (Cth) 424
public events and festivals 198
public transport
changing needs 360–1
infrastructure 360
in Perth, Melbourne and Copenhagen 362–3
pull factors 159
push factors 159

Q

Quality of Life Index 208
quaternary industry 378

R

railways, Sydney–Perth route and settlements 15
rain-shadow deserts 77–8, 242
rainfall
Australian annual rainfall variability 1900–2003 9
Australian average annual rainfall 9, 280
convectional rainfall 128
deserts 80
highest annual average 283
place with most rainy days 283
in rainforests 128
torrential rain 316
rainforests 24–5, 131–2
in Australia 134–5
canopy 131
characteristics 128–30
conservation 145–7
deforestation 139–41
ecosystems 131–2
emergents 131
forest floor 131
Indigenous peoples 136–8
layers in 131
physical processes 129–30
rainfall 128
types 128–9
understorey 131
Ramsar wetlands 56
recycling, e-waste 420–1, 423–5
regional relocation 169

relative humidity 280, 281
religious beliefs, community identity and 198–9
remote places
  Dawson, Canada 201–3
  inland locations 166–7
renewable resources 232
research findings, presentation 151, 227, 329, 431
resources
  renewable and non-resources 232–3
  types 232
restaurants 190
rice production, in Asia 260
rice terraces 102
Richter scale 110, 111
Rio de Janeiro State, 2011 floods 309
rivers
  in Australia 278, 283
  world's largest 282–3
roads 189
Rocky Mountains 99
run-off 235
rural areas
  regional relocation 169
  sense of community 171
rural towns
  attractions 193
  demography 194
  sense of belonging 194–5

S

Sahara Desert 75, 82, 94
St Katherine Protectorate, Egypt 102
saltpans 83–4
San Alfonso del Mar resort, Chile 282
San Andreas Fault 105
sand dunes 75, 81–3
sanitation 190, 261–3
satellite images 188
satellite phones 193
savanna 25
scale
  as geographical concept 14–15
  linear scale 45, 337
  as ratio 45
  on topographic maps 45
  using to calculate distance 93
scale statements 45
School of the Air 191, 192
sea change 174
secondary data 370
secondary industry 378
sediment 36
sedimentary basins 27
seismic waves 110
selective logging 139
sense of community 171
sense of place 156–7
services
  variations in access 191
  wellbeing and 189–90
settlements, and landscape degradation 62–3
severe storms 302
shanty towns 318
shield volcanoes 121
shifting agriculture 138
shifting cultivation 233
shipping
  capacity of container ships 357, 389
  global shipping routes 389–91
  growth in 357
  impacts of use of containers 392
  sustainability of 392
  technological advances 357, 390
  see also ports
shopping
  online shopping 193, 368
  in sparsely populated areas 193
shopping centres 190
Sierra Nevada 78, 108–9
Silala River 295
Simpson Desert 82, 85
Singapore
  interconnections 394
  strategic location 391, 394
  topographic map 365
sink holes *see* karst landscapes
sketch maps 179
Sky Muster satellite 417
Skype 366
slopes, measuring 103
slums 10
soaks 265, 266
social justice 401
social media
  demographics of usage 369–70
  most popular platforms 369
  weather warnings issued via 314, 324
social value, water 271
soft sport tourism 342
soil degradation 63
soils, volcanic soils 123
soldier settlement schemes 166–7
solubility, bedrock 37
space, as geographical concept 9
space tourism 348
spatial technologies 7–8
species diversity, loss of 141–3
SPICESS mneumonic 9
spiritual value
  landforms and landscapes 50–1
  mountain landscapes 101
  Uluru 58–9
  water 263–5
sport, tourism and 341–2
spot heights, on topographic maps 45
stalactites 37
stalagmites 37
star dunes 82
statistics 6
storm shelters 313
storm surges 316
storms, severe storms 302
stratosphere 245
stratovolcanoes 118
street view 164
Strzelecki Desert 85
Stuart, John McDoull 266
Sturt Stony Desert 86
subduction 105, 118
subsistence farming 232–3
subsistence lifestyles 136
subtropical deserts, formation 76–7
surveys 347
sustainability
  ecotourism and 350–1
  as geographical concept 13
  liveability and 209
  of shipping 392
  tourism and 348–9
sustainable development, rainforest conservation and 146
Sustainable Development Goals 214, 262, 404, 412
sweatshops 400
swimming pools, world's largest 282
Sydney 181
synoptic charts 247

T

Takla Makan Desert, China 75, 79
Tanami Desert 85
technology, connectedness and 199
tectonic forces 33, 34
tectonic plates 27
televisions, recycling 424
temperate climate 211
temperate rainforests 129
temperature, deserts 79
'ten pound Poms' 356
tertiary industry 378
tertiary study 338
Thames Barrier, London 310
Thanksgiving 343
Thar Desert 75, 79
thematic maps 130
thermosphere 245
Thinti-Thintinha Spring (Fred Springs) 265
Thredbo Landslide 66, 67
Three Gorges Dam, China 283
Three Sisters legend 101
Thutiria Pula 264
Tirari Desert 86
topographic maps
  area and grid references 30, 148
  BOLTSS 44
  borders 44
  contour lines 45, 118
  definition 44
  features represented 44
  interpreting 44–5
  legend 45
  orientation 44–5
  scale 45
  source 45
  spot heights 45
  title 45
  using 69
topography, water availability and 242
topological maps 364
Tornado Alley 313–14, 321

tornadoes 312–13, 321
torrential rain 316
Torres Strait Islander people 50
tourism
  adventure tourism 52–3
  at Victoria Falls 352
  cultural tourism 343–4
  ecotourism 147, 350–1
  future of 335–6
  future trends 348
  hard sport tourism 342
  importance 334
  increase in 334–5, 338
  as mass market product 348
  medical tourism 336–7
  negative impacts 345
  positive impacts 346
  soft sport tourism 342
  space tourism 348
  sport and 341–2
  sustainability and 348–9
  trends 335
tourist accommodation 339
tourist arrivals, trends and forecasts 6
tourist destinations
  places and types 334
  top ten countries 338
tourists
  backpackers 338
  countries of origin 339
  mature-aged tourists 338
  spending by 339
  sports tourists 342
  types 335, 338
trade
  in animals 386–7
  in Australia 376–9, 383
  exports 6, 383, 388–9
  fair trade movement 385, 401–2
  in food 385–7
  imports 383, 388–9
  interconnection of 376
  interstate and regional freight 378–9
  regional opportunities 384
  see also shipping
trade agreements 381–2
trade barriers 381
trading partners 382
Trans Pacific Partnership (TPP) 382
transport
  air travel 356
  cars 356–7
  connectedness and 199–200
  public transport 360–3
  railways 15
  roads 189
  shipping 357, 358–9
  strategies to improve liveability 222–4
  and technology 356–7
transport networks, historic settlements and 186–8
transportation (geomorphological process) 33, 34
travel, effects in local community 430–1
tree change 174
Triassic period 134
tropical rainforests 128
troposphere 245
tsunamis
  impacts 114–16
  Indian Ocean 2004 113
  Japan 2011 112
  occurrence of 112–13
  ten biggest 114, 115
tundra 25
Turkestan Desert 75
Twelve Apostles, Victoria 35
Typhoon Haiyan (Yolanda) 318–20
Typhoon Maysak 316–17

U

Uluru
  aesthetic value 58
  cultural and spiritual value 58–9
  economic value 60
  joint Anangu and Parks Australia management 61
  national park management 61
  traditional Aboriginal management 61
  World Heritage listing 61, 62
Uluru–Kata Tjuta National Park 61, 62
underground landscapes *see* karst landscapes
UNESCO (United Nations Educational, Scientific and Cultural Organization) 55
United Kingdom, Environment Agency 420
United Nations
  Millennium Development Goals 214, 261, 262–3, 404
  Sustainable Development Goals 214, 262, 404, 412
United States, decline of car industry 396–7
uranium 232

V

vegetation identification charts 99
Victoria Falls, Zambia and Zimbabwe
  topographical map 353
  tourist mecca 352
Vietnam, impact of Typhoon Haiyan 319
virtual fieldword 132
virtual water 271–2
visual representations 8
volcanic eruptions
  anatomy of 120
  predicting 124
  preparing for 124–5
  worst occurences 122
volcanic loam 123
volcanic soils 123
volcanoes
  in Australia 27
  and landslides 65–6
  Mount Etna 196–7
  resources associated with 122–3
  types 120–1
  world map 104

W

Wangkangurru people 264
waste 190
  see also e-waste
water
  aesthetic value 269–71
  cultural and spiritual value 263–5
  economic value 259–60
  impact on landscapes 34–6
  significance to indigenous people 267–8
  social value 271
  virtual water 271–2
water availability
  access to clean water 190, 261–3
  effect of climate in Australia 279–81
  global differences 282–4, 285
  and human right to water 284–5
  improved drinking water 285
  influencing factors 241–3
  water carriers 285–6
water consumption, individual efforts to reduce 293
water cycle
  changes in location and form 36, 234
  and factors that affect flooding 8
  key processes 234–5
water footprint 272–3
water management
  across borders 294–5, 296
  government role 292
  households 296
  Murray–Darling Basin 295
  NGO role 292
water pollution 257
The Water Project 292
water quality
  of local catchment 328–9
  pH levels 257
  salinity 258
  temperature 257
  turbidity 258
  and value of water 257
water resources 234–5
  in Australia 278–9
water restrictions 296
water rights 284–5
water scarcity
  absolute water scarcity 287
  causes 287–9
  economic water scarcity 287, 288
  global projections 290
  and human right to water 285–6
  physical water scarcity 287, 288
  strategies to address 292–3
water stress 285
water use
  in Australia 254–5
  global differences 254
water vapour 244
water-borne diseases 261
water-saving products 296
waterfalls 283

Waypoints 49
weather
  distinguished from climate 246–7
  influences on 244–5
weather stations 79
weathering 26, 34, 81
web 1.0 365–6
web 2.0 365–6
web 3.0 365–6
weirs 310
wellbeing, services and facilities 189–91
Western Australia, major regions 192
westernisation 372
wetland habitats 240
wetlands, Ramsar wetlands 56
Whataroa area, New Zealand
  topographical map 329
  water sources 298
Willandra Lakes 87–9
wind roses 304, 305
wind speed
  gale force winds 316
  measuring 304, 312
winter solstice 343
Wivenhoe Dam 308, 311
Wollumbin/Mount Warning 101
Woodlawn, NSW, topographical map 427
World Fair Trade Organization 401
World Heritage Committee 55, 61
World Heritage Convention 55
World Heritage List 55
World Heritage Sites 55–6, 61, 62, 89, 101, 134, 248, 298
World Wide Fund for Nature 292

Y

Yanomami people 145
youth culture, and ICT use 364
Yukon Quest dog-sled race 203

Z

Zero Gravity Corporation (Zero G), weightless flights 348
Ziilch 423